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HELEN CHANDLER

Alien Others: A Question of Space

IN HER ARTICLE entitled "Kidnapped by an Alien," Joyce Bynum states that "the tremendous recent increase in beliefs and stories about UFO's and alien abductions results mainly from the proliferation of printed material such as the National Enquirer and numerous UFO magazines and books, plus exposure to UFO-focused movies and television programs" (93-94). In this paper, I want to show how several films on aliens, along with the use of aliens in tabloids and literature devoted specifically to tales of alien abduction, contain certain tendencies of the culture we currently term as "postmodern," as these cultural tendencies are defined by prominent cultural and linguistic theorists. Thus, I hope to show that the manifestation of aliens in film and tales of abduction are significant ways that "alienation" is now redefined as a postmodern condition.

We are not "safe" from aliens, and we create the spectacle of the bad alien in order to magnify our fear of the unknown, so we won't be as fearful if the real thing does occur. But this is only an attempt at subverting this fear. The truth is, on the flipside, that we are victims who love the thought of being victimized. A perfect example of this is the title of a recent article in a popular tabloid: "Did UFO Cause Flight 427 Crash?" (Mann 40). The key word here is, of course, cause. In blaming the other, we'll never blame ourselves for alienating or for creating evil, because we think we're protecting ourselves from a dangerous "other."

This brings me first to Lacan's ideas about the "subject's" development in the "mirror stage." The knowledge of space which technology has given us has become what Lacan calls "paranoic knowledge," of knowing ourselves as earthlings and thus not aliens, of defining ourselves in a binary opposition to the "phantoms that dominate us" (Lacan 72). What is most frightening about this paranoic knowledge is that it has become our social norm. Thus, the fear of aliens has become far more than mere "fantasy" about the other: it has become our reality. This frightening reality fixes us in our places, subject to ceaseless inspection by little green men or horrible

monsters.

The manifestation of aliens in film and the press is also frightening because it adds a new dimension to the "us against them" syndrome: often the aliens we depict, whether hostile or benign, are more technologically or physically advanced than we are. Along these lines, the movies It Came from Outer Space (1953), The Invasion of the Body Snatchers (1955), Alien (1979), and Alien Nation (1987), all illustrate what Foucault says about the present culture: "We are neither in the amphitheatre, nor on the stage, but in the panoptic machine, invested by its effects of power, which we bring to ourselves since we are part of its mechanism" (88).

In The Invasion of the Body Snatchers, the aliens overtake the humans' bodies, exerting their power as the humans sleep, in order to create a society of aliens (in the humans' bodies) which have "no feelings...only the instinct to survive." In Alien Nation, the aliens are much smarter than the humans they co-exist with, and one adult human expresses distress because an alien child has proven himself smarter in school. Also, the aliens are physically stronger than the humans, because these aliens were originally slaves "adapted for hard labor in almost any environmental conditions."

In Alien, the alien is superior because it not only reproduces at a phenomenal pace, but also because, as one character says, "you can't kill it" and it is "unclouded, in a conscience amongst our delusions of morality." In It Came from Outer Space, one alien says, "We understand more," and then, "Let us stay apart...for to bring us together would only bring destruction." Exactly. It is the fear and hatred we feel toward a smarter and "better" other which distances us from this other, forming the basis for the projection of our hatred onto the alien.

The "truth" is that the fantasy of meeting the alien face to face has turned into the horror of being subsumed by a greater force. Yet we would much rather remain in the panopticon, because here there is what Foucault calls the "infinitesimal distribution of the power relations" (88), the fear and horror we feel about the unknown and the resulting power game we play within ourselves. The horror of the panoptic machine is probably best illustrated in It Came from Outer Space: in order for the aliens to "borrow" the humans' bodies, a huge eye emerges from a slimy blob of alien, hardly a subtle reminder of a panopticon.

All four of these films illustrate perhaps the most frightening thing about the panoptic machine: the fluidity of power relationships. Foucault says that "he who is subjected to a field of visibility, and who knows it...inscribes in himself the power relation in which he simultaneously plays both roles; he becomes the principle of his own subjection" (86). This theoretical power play is illustrated in the cinema's tendency to show a "weak-

ness" in the other; these films visualize and make tangible for us the fear of a power which we convert to our own power—power we exercise on ourselves which consequently "polices" our actions and keeps us in constant fear.

In The Invasion of the Body Snatchers, the aliens can be destroyed by fire while still in their seed pods. In one scene in It Came from Outer Space, an alien "clone" is killed by a deputy's shotgun. And in Alien Nation, the brainy aliens not only have a weakness for an addictive narcotic drug, but they can also be destroyed by salt water. And although Alien suggests no possible way to destroy the alien (other than dropping it from the ship into space), the next film in the trilogy, Aliens, reveals that the alien can be destroyed by fire.

That aliens are in the panoptic tower, ready to destroy us or take over our planet or at the very worst beat us at the knowledge game, brings me to this point: the tendency to represent aliens in film is part of our culture's battle with the totalizing metanarratives of terror (which it thrives on). In the four films I have discussed, aliens exist, in the now, and the sight of these horrible creatures is actually a comfort to us. Lyotard says that "the possibility of nothing happening...gives to waiting" (246). The aliens in these films, then, represent our defiance against what Lyotard calls the "now like the feeling that nothing might happen: the nothingness now" (246).

At one point in It Came from Outer Space, the aliens tell Johnny: "Give us time, or terrible things will happen. Things so terrible you have yet to dream of them." And Ellen asks Johnny, "What do we do now?" He replies, "We wait. We sit and we wait and we trust them to make it clear for us." These examples seem to explore the existence of metanarratives in society, showing both time and fear of the other as metanarrative. And at the end of the film, as in Alien, there is a wonder/fear/amazement at whether the aliens will come back or not. Until Hollywood can create another alien being, the film's characters and the audience alike are thrown back into yet another period of waiting. Lyotard also says that "what is terrifying is that the It happens that does not happen, that it stops happening" (251). So as long as films about the alien are produced, there will be a sort of "it happens that" for us to look to for justification of our terrible acts.

All of these films show a physical confrontation or a visual examination between the alien(s) and the humans, and yet somehow they also illustrate the waiting, the stasis we remain in while anticipating an alien visit. So what is our ultimate pleasure?

I think our pleasure is two-fold: 1) In confronting the alien, we no longer have the terror of waiting—in a sense this represents freedom (even if temporary) from metanarrative; 2) In being able to "win" against the alien,

temporarily shut it out, or at least to find its weak spot, we are keeping it "at bay, held back" (Lyotard 251). Alien films such as these give their audiences "positive satisfaction" in confrontation, but paradoxically continue the satisfaction with "privation"—or, at least by knowing the alien's weakness, the possibility of privation—and by **not knowing** what the alien will do next.

Along these lines, perhaps one of the most amazing characteristics of the tendency to depict aliens in film is the element of what Barthes calls "tmesis," the "source or figure of pleasure" (97). It's what happens when the alien finally "gets us" or makes contact. Barthes explains that the pleasure of reading a text comes from the "abrasions" one imposes "upon the fine surface" (97). The text of "bliss" is one which leaves a gap for the reader to fill, a feeling of loss which can only be quieted by the body's "erotic" pursuit of its own ideas (97). Of the four films I have discussed so far, three seem to me to exemplify tmesis. The crux of the process here, of course, lies not only in the entrance of an alien "other" into the human text [body], but also in the audience's warped, erotic pleasure in imagining the presence of another within.

Alien depicts this idea most vividly, and in a more complicated way. Cobbs states that "the concept of a subversive 'danger within' is...not new to the horror/sci fi genre, but the nature of the life-threatening, interior 'other' in Alien is of a particular sort: it is fetal" (201). After a sexual insertion of a long, phallic tube into the mouth of the human victim, the alien lays its eggs in the human's stomach. Then, gnawing its way out with ferocious teeth, the monster emerges from the victim's belly in a triumphant/birth act of horror/death.

To a lesser extent, the entrance of the alien into the human text is also exemplified for gap-filling viewers in It Came from Outer Space and The Invasion of the Body Snatchers. In both films, the aliens make a clone of the human and exist in his/her body. But in It Came from Outer Space, the real people are entered into only temporarily to create a clone, while the real humans are kept safe as the aliens pose as them in body. However, in The Invasion of the Body Snatchers, the aliens destroy the original human body after cloning—the aliens also take over the human's personality, becoming nearly identical, except that now (in the simulated person) there is no emotion, no feeling, no love.

This idea of tmesis is what I also find most fascinating about the accounts of alien abduction, whether in sensational tabloids or in books devoted to "UFOlogy." Here it is interesting to point out what Baudrillard says about the nature of the cinema: "Cinema increasingly approaches...absolute reality...in its pretension to be the real" (195). And he

calls cinema the "naive and paranoid," a "terrorist vision of signs" (196). Likewise, popular literature on and narrative accounts of alien abduction claim "authenticity" and the "real."

But it doesn't matter at all if these tales are true or false—if "commentary" indeed "supplants authority," then these accounts are the real—real enough to the readers and real to science, in its desperate attempt to make logical and rational the existence of aliens. Hence, from 1948-69, the US Air Force developed a task force called "Project Blue Book" in order to investigate UFO reports (Time-Life 87). But "on the whole, the Project Blue Book team...operated under an undisguised bias that UFOs did not exist" (87).

Interestingly, a recent article in New Scientist points to the culture's play on tmesis and fear. The article states that

if we establish contact with a civilization that is millenia more advanced than us, our knowledge, culture and identity will be subsumed into theirs....If evolution is really a universal principle, biologists point out that a more advanced life form should engulf ours. (3)

The aliens are thus even dreaded in the realm of science, because they could penetrate every facet of our very existence; but there is also a certain allure in something unseen and fantastic subsuming (or, more appropriately, penetrating) the human body and mind.

The Time-Life book The UFO Phenomenon, gives an unusual account of human/alien tmesis. In 1957, a Brazilian man claimed he had been abducted by aliens and had been "compelled" to have sex with a beautiful alien "woman" (86). And after their intercourse, she reportedly "pointed to her belly and then to the sky, leading the man to believe that she would bear his child" (86).

In his book of testimonies, Abduction: Human Encounters with Aliens, John E. Mack, M.D., includes the case of "Catherine," who describes how aliens abducted her and took samples from her uterus and fallopian tubes (155). The woman concludes that aliens "have lost all but the genetic material" and are thus using humans for their reproductive needs (Mack 161).

But perhaps most interesting in the realm of tmesis are the tales of alien abduction in popular tabloids. A recent article in Weekly World News entitled "Space Aliens are Abducting Housewives—and Having Sex with Them" describes a new book, Without Consent, by Carl Nagaitis and Philip Mantle. The article states: "A startling new book presents overwhelming evidence that space aliens are having hot steamy sex with Earth women—and the women are loving it!" (Lind 24). The article goes on to cite an ex-

ample from the book (of housewife Jane Murphy's account):

I looked into his big black eyes and knew what was going to happen....It was like a dream. As he drew near to me I noticed his smell. It wasn't a human smell at all....It was the best sex I ever had. (24) Another woman, who had a doctor's exam after her "experience," was believed by her doctor to have had an ectopic pregnancy. The article says that "scientists believe the aliens may have impregnated her and then aborted the pregnancy" (Lind 25).

The point here is that alien abduction is real to us—the stories of narrated experiences and sensational tabloids supersede science, so that vivid, spectacular descriptions and media manipulation have created the condition, the binary opposition in which we define ourselves: as either believers or non-believers.

Bynum notes that "UFOlogy provides a ready-made language of description and interpretation, and an eager, willing, and huge audience. Without these elements, abduction tales could not possibly exist" (95). She quotes Thomas Bullard, who says that "science may have evicted ghosts and witches from our beliefs, but it just as quickly filled the vacancy with aliens having the same functions" (95).

That function, of course, is as the "other," the provoker of fear and an alluring dread, the logical recipient of blame, and as the tool for a capitalist society's "will to spectacle" in order to prove just how strong and normal we are—and especially how superior we are—because we can manipulate, parody, and make spectacle of anything we fear.

It is at this point that I must risk totalizing and include that, along with our notions about the "evil" other, what ties the alien films to stories of abductions in popular books and tabloids is what Baudrillard calls the "will to spectacle" (357). He says that "humanity can accept physical annihilation, but cannot agree to sacrifice the spectacle" (358). The "drive to revert to the spectacle" is exemplified in films and popular reading because we must be "enraptured" in the spectacle, caught up in our fear of the unknown so much that we crave the experience of *tnesis* (in this case sex with aliens or aliens inside us) as a norm.

Films and popular reading on aliens exemplify what Jameson calls the "underside" of capitalist culture—"blood, torture, death, and horror" (65)—because these expose our tendency to want to shock ourselves through spectacle while we make a profit, what Lyotard calls the "collusion between capital and the avant-garde" (255). Here is a quote from a 1979 review of Alien, which illustrates this capitalist terror and use of spectacle:

Alien's sets and special effects are well done, but these things no

longer surprise or tantalize us as they once did....There's also the obligatory shot of that huge space vehicle early on in every film.....When I first saw it in 2001, it was awesome. Now it makes me feel like a turtle on a busy though unnaturally quiet highway. (New York Times 48)

Does alien propaganda thus expose itself and the culture which produces it, overtly saying: "Here it is"? Here is the ultimate manifestation of the present (capitalist) culture's tendency toward spectacle; the identification of and destruction or weakening of the other; the fear of the unknown other thus subverted and exposed as unthinkable terrors (which, with every attempt, become more and more spectacle in order to produce shock—only to become the norm); the culture's eager and erotic drive toward the mimetic theme of the other within; and the realization that a capitalist economy has denied the real and the subject's emotions in favor of what Carl Freedman calls a "technology of emotion" (186) in order to produce spectacle and to commodify "the other" for the ultimate goal of profit.

Yes; in fact, it's simply obvious what we're all doing—fragmented stimulation is better than none at all.

Thus, the depiction of aliens in films and popular literature has become a genre of the postmodern condition. Defining this depiction as such may seem an attempt to lean toward the "social norm," the "status quo" of categorization: but it is the tendency to "propagandize" something we aren't even sure exists into films and tabloids which makes this alien topic a capitalist/postmodern phenomenon—a reflection of cultural theory and thus of the culture.

What to be done is to exacerbate this agitation with the unknown into even more incredible mutations of the object and subject that will adhere to the cultural tendency to produce something new and shocking—but before further mutation, we must accept that we will not (and cannot) be shocked for any long period of time, and we must see that postmodernism will not culminate into a fixed genre but rather a changing genre which changes with the whims of the culture it reflects, **as long as what is created is fantastic or exaggerated.**

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Helen Chandler is a Senior English major/Psychology minor. She plans to attend graduate school in Literature at the University of Washington. She hopes to one day become a writer/reporter for The Weekly World News and also to one day meet a space alien.

PETER T. CHANG

*Specific Binding of the Mouse Thymidylate Synthase
to its Messenger RNA*

THYMIDYLATE SYNTHASE (TS) is an enzyme necessary for the *de novo* synthesis of thymidine monophosphate (dTMP), a DNA precursor. Previous studies have shown that the human TS mRNA translation is negatively autoregulated by its own protein end-product, TS, which binds to the mRNA at the identified binding sites (6-7). In this paper, the interaction between the mouse recombinant TS protein and its mRNA was studied *in vitro* for a similar behavior using the nitrocellulose filter-binding assay. The study indicates that the mouse TS protein indeed has a specific binding interaction with its mRNA, through which the catalytic activity of the protein is disabled. The mouse TS mRNA can act as an inhibitor of the mouse TS enzyme because the ribonucleoprotein complex is preferred to the protein-substrate formation. The binding of the mouse TS mRNA appears to be due to a secondary structure, such as a stem-loop, rather than a particular sequence of few nucleotide bases. Ideal interaction conditions were also investigated.

Thymidylate synthase (TS) is the enzyme that catalyzes the synthesis of thymidylate (dTMP) and dihydrofolate (FH_2) from 2'-deoxyuridine 5'-monophosphate (dUMP) and the cofactor $\text{N}^5, \text{N}^{10}$ -methylene-tetrahydrofolate (CH_2FH_4) in the *de novo* biosynthetic pathway (1). TS enzymatic activity can be inhibited by FdUMP and its analogues since the fluorine cannot be displaced from the active site once the covalent ternary complex of TS, FdUMP, and the cofactor has formed (2). In its active form, TS is a homodimer composed of two identical subunits each with a molecular weight of 34,962 daltons (2-3). Expressed at a very low level in quiescent cells, the TS gene expression is increased in rapidly proliferating cells by approximately 20-fold at the G1/S phase boundary of the cell cycle (4). The expression of the TS gene has been shown to be regulated at the transcription, RNA process-

ing, mRNA translation, mRNA stability, protein stability, etc (1). Because of its crucial role in DNA replication, TS has been a target of intense cancer chemotherapy research (5).

Previous studies with the human recombinant TS protein have indicated that TS autoregulates the translation of its own mRNA in a negative manner by binding to the messenger at the specified sites and preventing translation (6-7). In contrast, the interaction between the mouse TS and its mRNA has not been thoroughly examined. Although the TS protein's amino acid-sequences in general are incredibly conserved throughout evolution, especially between the mouse and the human TS, the region around the AUG codon site, which was identified as the major binding site between the human TS and its mRNA (7), is very poorly conserved (3). This prompted an investigation into the mRNA-protein binding interaction in the mouse to study whether a similar autogenous translational control mechanism may have been conserved across a relatively brief evolutionary stage.

The research led to the discovery of ideal binding conditions and incubation time. The analysis also revealed that the mouse TS mRNA binds specifically to its translational end-product, TS, *in vitro* as observed in the human system (6). Further studies show that TS mRNA binds to TS and prevents the protein from retaining its catalytic activity, therefore, suggesting that the mRNA-binding site may overlap with TS protein's active site for its normal substrates *in vivo*, dUMP and CH_2FH_4 . Furthermore, the mRNA's ability to bind to TS appears to depend on the formation of a secondary structure rather than a particular nucleotides-sequence.

MATERIALS AND METHODS

Preparation of Plasmid Constructs and *in Vitro* mRNA Transcripts.

The mouse TS cDNA clones were gifts from T. Xiang (Department of Molecular Genetics, Ohio State University, Columbus, OH). Full TS cDNA had been inserted at the *Sac I* site of the pBluescript II KS(-) phagemid to give clone 12 and also clone 2, which has the same region in the inverted position. Clone 12 and clone 2 were linearized at the *HindIII* restriction site and then transcribed with T7 RNA Polymerase (GibcoBRL) to give full-length transcripts (nt -85 to end) and full-length anti-sense transcripts, respectively. The mouse TS upstream cDNA clone (TS 380-U) and ribosomal protein cDNA clone (RP 243) were gifts from T. Xiang, as well. TS 380-U, which includes nt -382 to -207 of TS, was linearized at the *Xho I* restriction site and transcribed with T7 RNA Polymerase to give a 284-nt RNA. RP 243 was linearized at the *Sst I* (*Sac I*) restriction site and transcribed with T3 RNA Polymerase (GibcoBRL) to give a 323-nt RNA. Partial-length TS RNA transcripts

of 111-nt (nt -85 to +26) and 250-nt (nt -85 to +165) were synthesized from the clone 12 with T7 RNA Polymerase by linearizing at the *Pst* I and the *Sph* I restriction sites, respectively. The digestion with *Pst* I produced three DNA strands, among which one containing the cDNA of interest was band-isolated from the 1% agarose gel using the spin-column technique with Ultrafree-MC 0.45 μ m Filter Unit (Millipore, Bedford, MA). All labeled mRNAs were transcribed from their corresponding cDNAs according to the Promega protocol with the use of [α - 32 P]-UTP (specific activity, 3000 mCi/mmol; ICN, Irvine, CA) and analyzed on a 6% sequencing gel. In order to produce transcripts of higher specific activities, the transcriptional mixtures for TS 380-U, RP 243, 111-nt TS, and 250-nt TS included twice the normal amount of [α - 32 P]-UTP but lacked non-radioactive UTP. The cDNA clones linearized with *Sst* I (*Sac* I), *Pst* I, or *Sph* I produced 3' overhangs which were converted to blunt ends with the use of Klenow DNA Polymerase (GibcoBRL). The final molarity of the labeled mRNAs was diluted to approximately 200,000 CPM/ml.

TS Protein Evaluation. The mouse recombinant TS protein was a gift from Lee F. Johnson (Department of Molecular Genetics, Ohio State University, Columbus, OH). The purity of the TS protein was verified by one-dimensional SDS-PAGE. Protein concentrations were determined through Bio-Rad Protein Assay using the bovine serum albumin for the derivation of the standard curve.

TS Protein Activity Assay. In a 1.5 ml cuvette, the following reagents were mixed: 0.69 ml H₂O, 100 μ l of 1.0 M KPO₄ (pH 7.0), 100 μ l of the cofactor mix [1 mM tetrahydrofolate (Sigma) in 25 mM NaHCO₃ (pH 8.5), 32.5 mM formaldehyde, 125 mM 2-BME], and 100 μ l of 1 mM dUMP. Change in the absorbance at the wavelength of 340 nm was measured for approximately 2 min. after 5 μ l (3 mg/ml) of the enzyme was added to the mixture and allowed to react; the results were compared against the controls, which lacked either or both of the substrates, to confirm the activity of the TS protein. 3 mg/ml TS enzyme had the activity of approximately 60 units/ml. All measurements were made on Milton Roy Company Spectronic 1001 Split-beam Spectrophotometer.

Nitrocellulose Filter-Binding Assay. Nitrocellulose filter-binding assay is used to study protein-nucleic acid interaction because of nitrocellulose's preference for proteins and protein-nucleic acid complexes but not for free nucleic acids (8). The assay conditions originated from the previous studies with the human TS and tyrosyl-tRNA synthase (7; 9) and were modified to improve the binding interaction. 1.00 ml of 32 P-labeled RNA (approximately 200,000 CPM) was incubated with 1.25 mg of recombinant mouse TS in 2x TS binding buffer [20 mM Hepes (pH 7.6), 6 mM

MgCl₂, 80 mM KCl, 10% glycerol, 400 mM 2-BME, 4mg/ml of the nonspecific competitor yeast total RNA] in total reaction volume of 50 ml for 60 min. at 37°C and placed on ice to await filtration. Immediately before filtration, the samples were diluted with 450 ml of 1x TS binding buffer. The samples were then filtered under gentle vacuum through a nitrocellulose filter (13 mm; Schleicher & Schuell, Inc., Keene, NH), which had been pre-soaked with the TS washing buffer [10 mM Hepes (pH 7.6), 3 mM MgCl₂, 40 mM KCl, 5% glycerol, 200 mM 2-BME, 40 mg/ml denatured salmon sperm DNA] for overnight. Before the vacuum pump was turned on, the samples were allowed to interact with the filter for 1 min. After filtration, the filters were washed four times with 1 ml of the TS washing buffer and dried on Whatman paper for 20 min. Radioactivity retained on the filter was quantified by Beckman LS 2800 scintillation counter or by Betascope Model 630 Blot Analyzer (Betagen).

RESULTS

Binding Conditions. The primary objective of this research was to determine the existence of binding between TS and its mRNA. Using the original conditions described in previous, similar experiments, TS mRNA-protein binding was observed. Then, a series of experiments was performed to improve the condition of the binding interaction. The samples were incubated for 30, 60, 120, or 240 min. to determine the effective incubation period and to possibly study the kinetics of the binding interaction (Figure 1). Among the experimental conditions, 30-min. incubation appears to be the ideal incubation period; the relative binding activity decreases with longer incubation periods. [MgCl₂] was also investigated for its effect on the binding interaction (Figure 2). The experiment employing various concentrations revealed that the ideal [MgCl₂] is approximately 1 mM instead of the standard condition of 3 mM used throughout this project and in the human TS studies (7). Interesting observation was made with the use of the 0 mM [MgCl₂] buffer which also contained 1 mM EDTA. The counts had dramatically decreased if the sample was placed on ice for approximately 5 min. after the standard incubation at 37°C. Similar phenomenon was not observed in any of the other buffers tested. It appears that Mg⁺ functions to stabilize TS protein and/or TS mRNA so that the binding interaction may occur more effectively. Messenger RNA-protein complex appears to disassociate rapidly at 0°C in the absence of Mg⁺. Also critical is the rate of filtration of the sample (data not shown). Filtration rate must be slow enough to allow protein-mRNA complex to completely interact with nitrocellulose and bind to the filter.

Specific TS mRNA-Protein Binding. The mouse TS mRNA was incubated with various proteins to determine the relative binding between the mRNA and mouse TS protein (Figure 3). The result shows that the binding is protein-specific. In order to further establish the specificity of the TS mRNA-protein binding, TS protein was incubated with random mRNAs, including the ribosomal protein mRNA which is often used in an experiment to establish a specific relationship (Figure 4). The data, taken together with the result from the prior experiment, clearly demonstrate that the binding between TS mRNA and its translational product, TS, is highly specific to both the protein and the messenger RNA.

Region of TS mRNA-Protein Binding. In order to determine whether the mouse TS mRNA also has a TS protein binding site around the AUG codon site as observed in the human system (7), TS mRNAs of shorter fragments concentrated around the AUG site were incubated with TS under the standard condition (Figure 4). It appears that the mouse TS mRNA's protein-binding site is not contained within nt -85 and +165. An experiment using the anti-sense TS RNA demonstrated that the anti-sense TS RNA can bind to TS equally as well as the sense strand (data not shown).

Effects of Substrates. In the human TS studies, treatment of the reaction mixture with TS substrates (dUMP, FdUMP, and CH_2FH_4) prevents the binding between TS and TS mRNA and allows the translation of the messenger RNA to produce new TS proteins (6). In this experiment, FdUMP or UMP and the cofactor (CH_2FH_4) were mixed prior to the addition of the mouse TS protein to the binding mixture (Figure 5). FdUMP instead of dUMP was used since dUMP would simply be converted into TMP by the action of TS. Although the binding activity was reduced to less than 40% of the standard condition, the binding is quite significant, especially considering that the amounts of the substrates used were 160 times the molar concentration of TS protein, or twice the concentration that completely inhibited the binding in the human TS studies (6). Similar results were observed when TS mRNA was added to the binding mixture only after the covalent ternary complex had formed (Figure 6). The sample containing UMP and the cofactor, which was used as a positive control since UMP is not TS's substrate, also exhibited a decreased binding interaction. Further experiment shows that the decrease is due largely to the presence of the cofactor rather than UMP (Figure 5).

Catalytic Activity of mRNA-bound TS. To determine whether TS protein bound to the mRNA retains its catalytic ability to synthesize TMP, an experiment was performed in which ribonucleoprotein complex, formed by incubating TS with the excess of TS mRNA, was reacted with its substrates (Figure 7). The change of absorbance at 340 nm, which actually mea-

sure the formation of dihydrofolate, was compared to the controls in which the substrates were reacted with TS alone. Result shows that mRNA-bound TS protein loses its catalytic activity, indicating that the ribonucleoprotein complex is indeed favored over the protein-substrate formation and that TS protein cannot bind to the mRNA and the substrates simultaneously, although the binding sites may or may not be different. Consequently, the mouse TS mRNA is, in effect, TS enzyme inhibitor.

DISCUSSION

The results of this study show that the mouse recombinant TS protein does, in fact, bind to its own mRNA in a protein-specific, messenger-specific manner and that the protein binding domain does not appear to be contained within the close proximity of the AUG codon site. The latest study with the human TS has, however, revealed that the protein binds to the mRNA of the nuclear oncogene *c-myc* (10). The finding suggests that TS is indeed able to bind to an irrelevant mRNA. Whether the mouse system behaves similarly needs to be investigated. Regardless, these experiments need to be repeated, especially via a mobility gel-shift assay that would eliminate the complication of varying molar activities of the radioactively probed messenger RNAs, which naturally arise in the quantification of the data from a filter-binding assay. Moreover, although the experiments demonstrated that the protein-binding site is not localized within nt -85 to +165 (Figure 4), it is possible that a potential binding site may need to be stabilized or supported in some fashion by a secondary structure formed by a nucleotide-sequence further downstream. The fact that the anti-sense TS mRNAs bind to TS protein just as well as the sense strands suggests that the protein-binding domain on the mRNA is not a particular sequence of nucleotides, but rather a secondary structure, such as a stem-loop, that can be formed by complementary nucleotide-sequences. Further investigation is necessary to determine precisely the region(s) and the mechanism of the binding interaction. Such studies may eventually lead to the discovery of transferable domains that can be used to manipulate the level of proteins in a system.

The apparent decrease in the relative binding activity with the longer incubation times (Figure 1) can be accounted for by the spontaneous and RNase degradation of the messenger RNAs and the protease inactivation of the proteins. Later experiment in which TS was incubated alone for 60 min. and then 60 more min. in the presence of TS mRNA provided the evidence since the sample's relative binding activity was higher than the activity of the sample which was incubated full 120 min. in the presence of TS mRNA,

yet lower than the activity the sample which was incubated full 60 min. with TS mRNA (Figure 6). The relative binding activity, in effect, only measures the retained radioactivity due to mRNA portion bound to the protein. Therefore, if any mRNA degradation or protein denaturation occurs, the quantified binding activity may be lower even though the actual occurrences of the mRNA-protein binding may be increasing with longer incubation times.

Certain anticancer chemotherapeutic drugs, such as 5-fluorouracil (FUra) and 5-fluorodeoxyuridine (FdUrd) which are converted to 5-fluorodeoxyuridylate (FdUMP) in the cells, inhibit the TS protein's activity by binding to the protein's active site and forming a stable, covalent ternary complex that can no longer catalyze the dTMP-synthesis reaction (2). According to the autoregulatory mechanism, however, such drugs would increase the rate of translation by disrupting the binding between TS and the mRNA, thus ultimately leading to an increased amount of TS in the system. In fact, human mammary epithelial cells exposed to the folate analogue ICI D1694 exhibit 40-fold elevation in TS enzyme level (11). Consequently, such drugs would have opposite of the desired effect. Therefore, important would be to study whether the mouse TS mRNA bound to TS would be inhibited from translation as in the human system (6). Since the data from this paper show that the mouse TS mRNA can be used as an inhibitor of TS enzymatic activity, protein-binding domain of the mRNA may be inserted into the genome of the human cancer cells to act as the anticancer agent, if the domain is compatible with the human TS for binding. Such study, together with the comparison and the contrast of the two systems, may result in finding an anticancer chemotherapeutic drug that is capable of eliminating the catalytic activity of TS without interrupting the binding interaction between the protein and the mRNA.

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Notes

1. Johnson, L. F. (1994) Posttranscriptional regulation of thymidylate synthase gene expression. *J. Cell. Biochem.* 54: 387-392.
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Pete Chang is a biology major and mathematics minor from Birmingham. He is pursuing a career in medicine and will attend the University of Alabama in Birmingham School of Medicine in the fall.

Figure 1

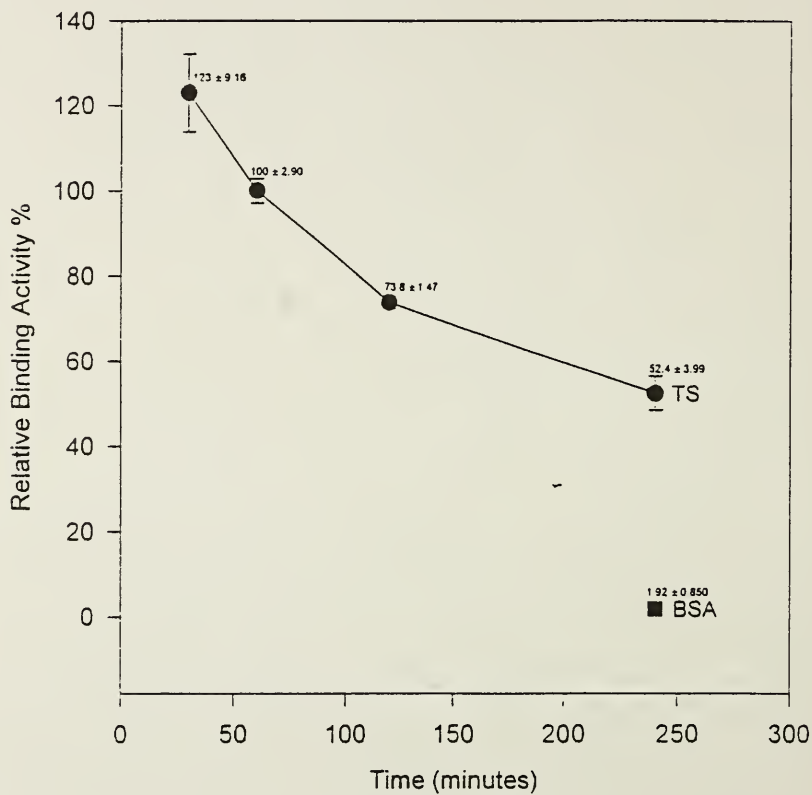


Figure 1. Binding vs. Time. TS protein was incubated with TS mRNA at 37°C for 30, 60, 120, or 240 minutes under the standard condition. Bovine serum albumin was used as a control for the experiment. The values are normalized to 100% of CPM from 60-min. incubation.

Figure 2

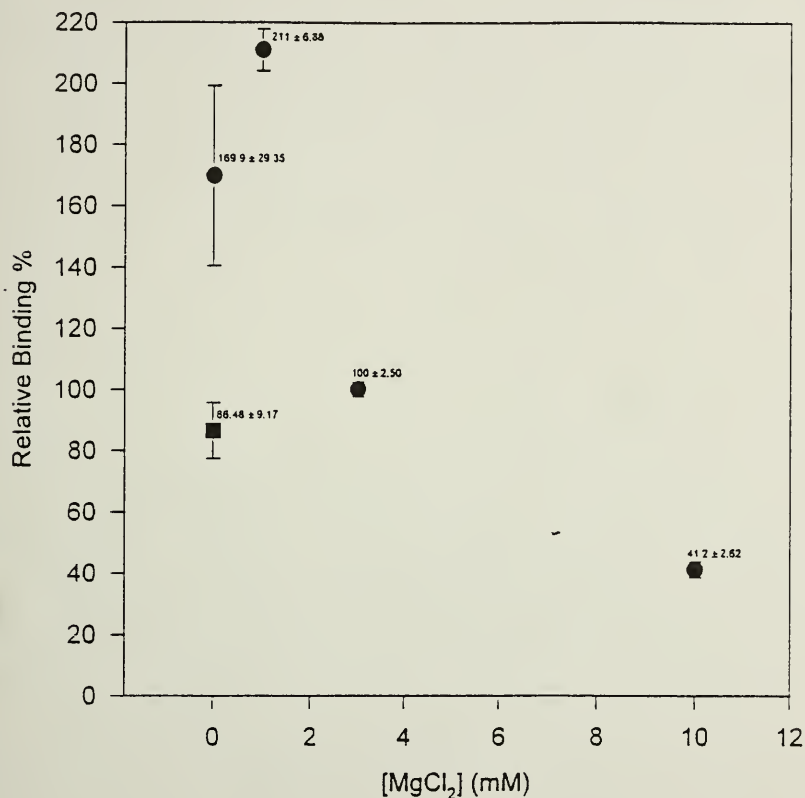


Figure 2. Binding with Varying [MgCl₂]. TS protein was incubated with TS mRNA using binding buffers with varying [MgCl₂] (0, 1, 3, and 10 mM). The washing buffers with the appropriate [MgCl₂] was used to wash the filters after the filtration. All filters were, however, presoaked in the same standard washing buffer with 3 mM [MgCl₂]. The binding and the washing buffer with 0 mM [MgCl₂] also included 1 mM EDTA. The lower value represents the mRNA-protein binding after the sample had been placed on ice for over 5 min.

Figure 3

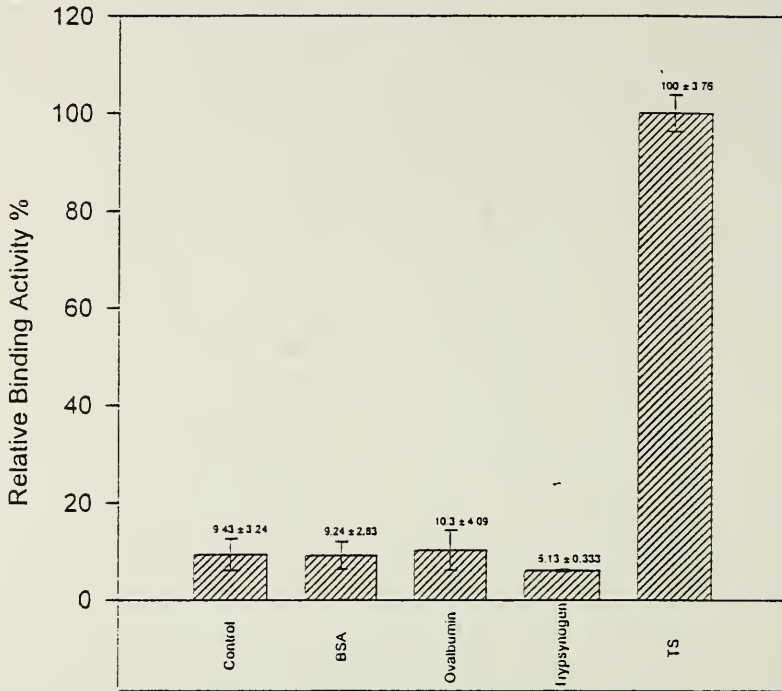


Figure 3. TS mRNA binds to TS. Control was incubated with the appropriate volume of TS lysis buffer [50 mM Tris-HCl (pH 7.0), 1mM EDTA, 12 mM β -mercaptoethanol, 0.1% Triton X-100, 10% glycerol, 0.2 M KCl] instead of TS. Mouse TS mRNA was incubated with the same amounts (by mass) of bovine serum albumin (BSA), ovalbumin, trypsinogen, and TS. The mRNA-protein bindings determined from the radioactivity retained on the nitrocellulose filters were normalized to 100% using the CPM from the sample with TS as the standard. 100% binding is equivalent to approximately 10,000 CPM.

Figure 4

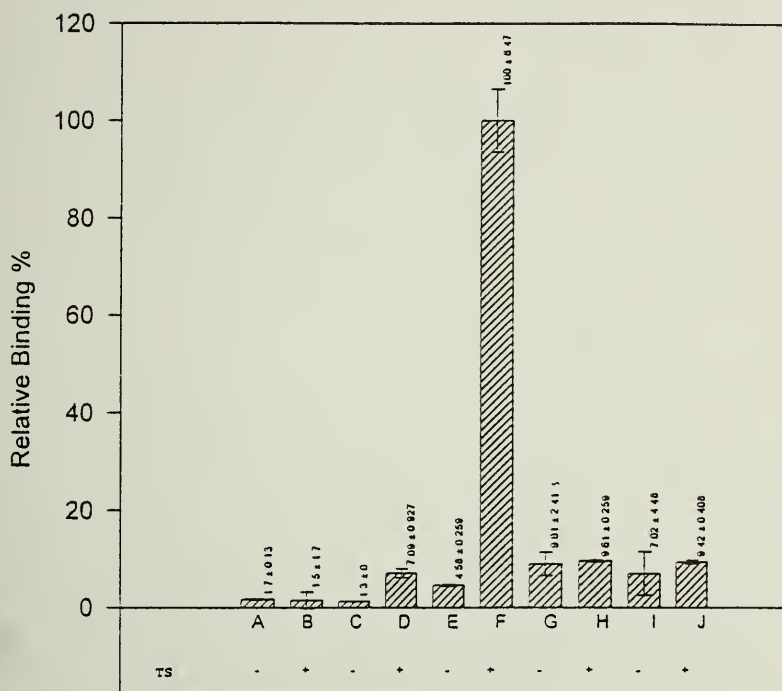


Figure 4. TS Protein Binding with mRNAs. Either TS protein or the equivalent volume of TS lysis buffer was incubated at the standard condition with 111-nt TS partial transcript (A & B), 250-nt TS partial transcript (C & D), full-length TS transcript (E & F), TS 380-U mRNA (G & H), and RP 243 mRNA (I & J). The values are normalized to 100 % of the CPM from TS protein-TS full-length transcript binding.

Figure 5

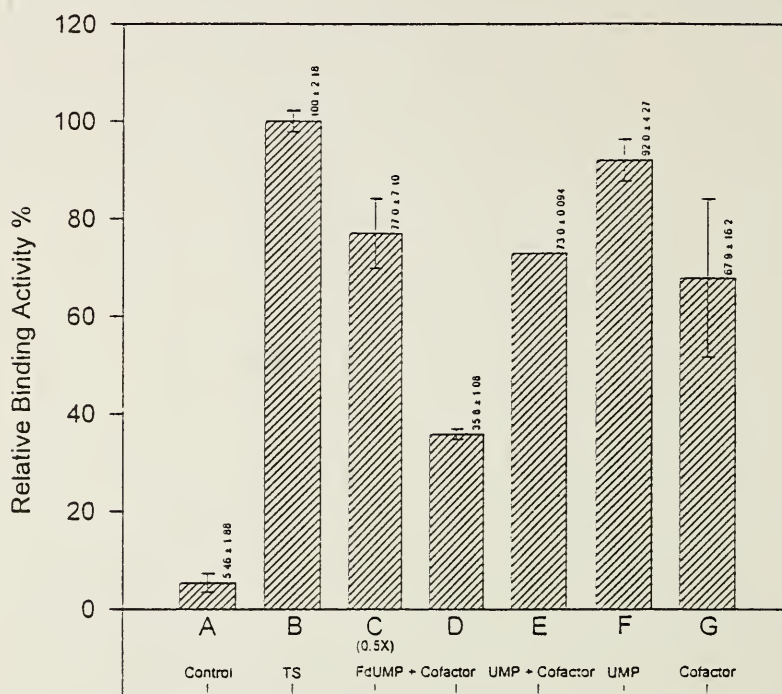


Figure 5. Substrates' Effect on Binding. TS protein was incubated with TS mRNA in various binding buffers, some of which contained TS's substrates. Control was incubated with TS lysis buffer instead of TS (A). B represents the standard condition. In C, FdUMP and the cofactor mix were included in the binding buffer at 80-fold molar concentrations compared to [TS]. In D-G, each additive was at 160-fold molar concentration compared to [TS].

Figure 6

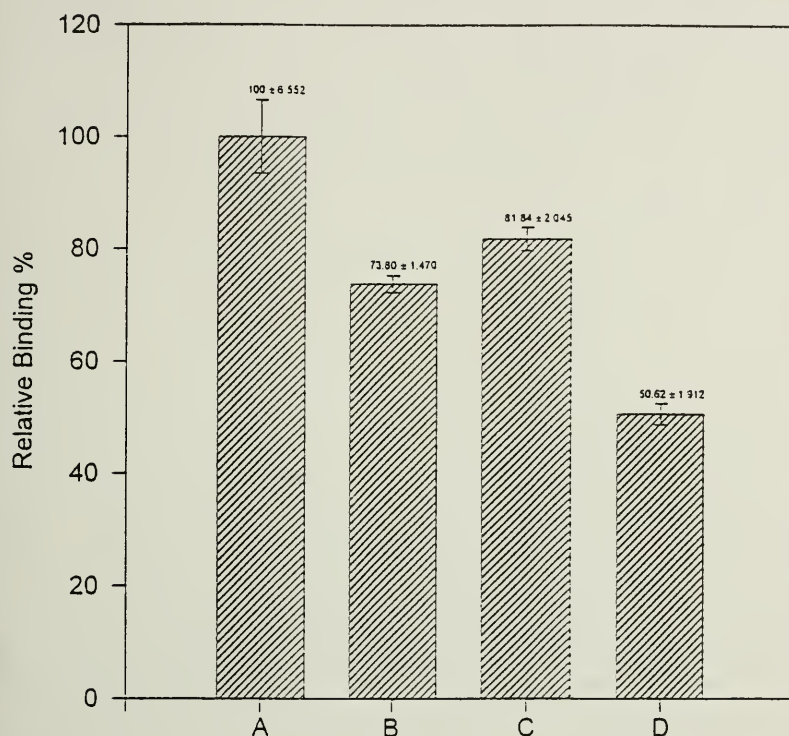


Figure 6. mRNA Binding to TS-Substrate Complex. TS was incubated with TS mRNA at the standard condition (60-min. incubation with no substrates) in A. The samples were incubated for 120 min. in B. In C, TS was incubated at 37°C for the first 60 min. only with the standard binding buffer and then incubated further for 60 min. after the standard amount of TS mRNA was added to the samples. In D, TS was first allowed to form the stable, tertiary complex with its substrates by incubating at 37°C for 60 min. with 160-fold molar concentrations of FdUMP and the cofactor mix; TS mRNA was then added and the samples were incubated further for 60 min.

Figure 7

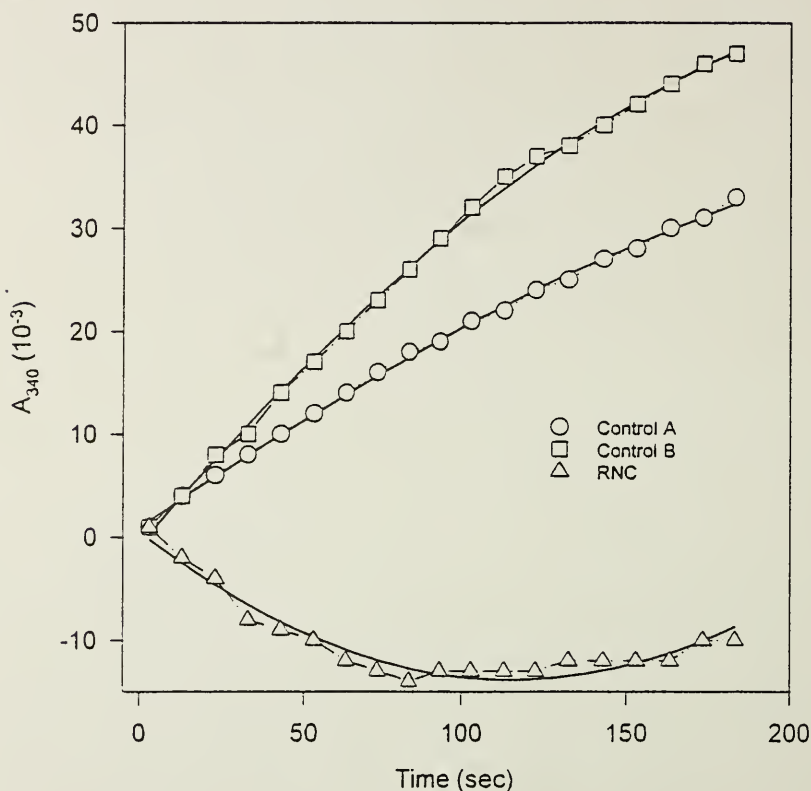


Figure 7. Catalytic Activity of mRNA-bound TS. 3 μg of TS protein was mixed with 33 μg of TS mRNA in 82 μl of the standard binding buffer to initiate formation of the ribonucleoprotein complex (RNPC). For the controls, equivalent volume of TE buffer was substituted for the mRNA (Control A & B). Control A was not incubated; control B and RNPC were incubated for 30 min. at 37°C. The catalytic activity of TS was measured by mixing the reaction mixture with 158 μl of H_2O , 20 μl of 1 M KPO_4 (pH 7.0), 20 μl of the cofactor mix, and 20 μl of dUMP, then observing the absorbance at 340 nm using Milton Roy Company Spectronic 1001 Split-beam Spectrophotometer.

MURRAY DUNLAP

*The Literature of the 1960s:
A Beneficial Disturbance*

WE ARE TRAPPED in roles that have been forced upon us . . . There is a strong desire to step out of all this into some kind of free space . . . Kesey knew very well how upset people can become when their reality picture is disturbed, but he acted on the assumption that such a disturbance is beneficial.

-Tony Tanner, *City of Words*

Strange days have found us
Strange days have tracked us down
Their going to destroy
Our casual joys.
We shall go on playing
Or find a new town.

-Jim Morrison, "Strange Days"

Literature, as a concept, always has been and always will be a reflection of those who write it as well as those about whom it is written. For this reason, it is clear that the literature of a period can reveal as much about an era as the historical documentation provided by the media and press. Works like *One Flew Over the Cuckoo's Nest*, by Ken Kesey, *Soul on Ice*, by Eldridge Cleaver, and *The Electric Kool-Aid Acid Test*, by Tom Wolf, express the desires of a generation boiling within its confinement. With a new distrust for their elders, new drugs to "expand" their minds, and new music rippling through the air waves, the youth of the 1960s made perfect inspiration for the anger, fear, and outright rebellion portrayed in these books. Not only do these books provide reflections of the social break-out, the movement against traditional social norms and expectations; they also show a definite break in the writing itself (many grammatical and structural rules of conventional Western writing are left behind). While *Soul on Ice* and *Acid Test* portray these emotions in direct nonfiction style and *Cuckoo's Nest* remains completely fictitious, all of these works can be read as vivid allegories for the social break-out into freedom in the 1960s.

state of society prior to the 1960's is necessary. The 1950s are generally considered an era of stagnation. From the old, conservative president (two characters in *Cuckoo's Nest* decide who is "crazier" based on the number of times they voted for Eisenhower) to a ridiculously sullen architectural style (as seen in the monotonous suburban conformity), America seemed to represent itself. Norman O. Brown, in his book *Life Against Death*, states that based on Freud, "man makes his own reality." He also states that when man represses himself he creates a society which does the same. Consequently, a society is formed that imposes repression upon itself, thereby stifling freedom. Brown feels that the society of the 1950s did just that (9).

A perfect example of this can be seen in William Whyte's *Organization Man*. In his description of the "organization," people of the 1950s have lost their individuality within the collective. This loss of individuality is the "common denominator" of repression in the organization, and subsequently the prisoner of the collective is unable "to control [his] direction" (3-4). If Brown's theory holds true, then the "organization man" of the 1950s was only a reflection of our own cultural neurosis. The 1960s, in turn, may be seen as a self-psychoanalysis in which our society explored new limits in order to release itself from the past.

These explorations became the groundwork for the 1960's social revolution wherein people began not only to question the "organization," but to attempt to break out of it as well. This social turbulence is embodied perfectly by the 1962 novel *One Flew Over the Cuckoo's Nest*, by the infamous Ken Kesey. Kesey, who was arrested several times, who fled the law by hiding in Mexico, and who staged public "Acid Tests" to create a new social experience, became a cult hero to the segment of youth seeking out new ways to live. *Cuckoo's Nest* is the depiction of a confining psychological ward brought to life by a brusque, defiant character named Randle McMurphy. Once in the ward, McMurphy begins to turn the docile conforming patients into individuals, who among other things, begin to speak up for themselves. This behavior is intolerable to "Big Nurse," the authority figure in the book, and she uses all of the power she can extract from the "system" to quell their insurrection. These powers, including shock-treatment and the ultimately destructive lobotomy, are manipulated by Big Nurse like a prison of complete control.

In a more general sense, the entire ward of *Cuckoo's Nest* is a controlling device run and operated by the system, or "combine" as Kesey's character Big Chief puts it: "The ward is a factory for the Combine. It's for fixing up mistakes made in neighborhoods and in the schools and in the churches" (Kesey 40). As seen through the eyes of Big Chief (a large American Indian patient pretending to be mute), the combine is a mechanism within

the system that can control the patient held tightly inside. Big Chief, who seems to suffer from schizophrenia, "sees" things like machinery in the walls, fog from machines, and hidden microphones. He even explains how he gets lost in the fog; but compared to the reality of the ward, "being lost isn't so bad" (118).

McMurphy, who recognizes the power of the system right off, states that there are "people who try to make you weak so they can get you to toe the line, to follow their rules, to live like they want you to" (57). McMurphy goes on to describe the way the system implements its philosophy through a familiar metaphor. He explains that when you get "kneaded in the nuts in a brawl," that it "stops you cold, don't it" (57). Through this easily identifiable experience, Kesey implies that the system holds people down by taking out their most basic form of individuality, their gender. This is also a cheap shot, referring back to the brawl, and like a knee in the groin, lets an opponent win by "making you weaker instead of making himself stronger" (57). Kesey is certainly taking his own shots at the system with this metaphor, and seems to abhor the helpless nature of the society it controls.

The connection Kesey is making between the ward and the real life "system" of the 1960s becomes even more apparent when Big Nurse, aptly named Ms. Ratched (ratchet and wretched are brought to mind here), is looked at in terms of a political leader. Her physical description is that of a precision machine; "I see her sit . . . like a watchful robot, Tend[ing] her network with mechanical insect skill . . . to get the results she wants" (30). She works in synchronicity with the system; the robot like nature of her stiff walk, her "precise, automatic gesture, (11)" and her calculated speech all working toward the goal of keeping her power secure. Sometimes the Big Nurse becomes even more machine-like in her appearance. When Big Chief, who is possibly schizophrenic, witnesses her getting angry at the work crew of black boys, he visualizes Big Nurse

swelling up, swells till her back's splitting out
of the white uniform and she's let her arms
section out long enough to wrap around the three
of them . . . and she blows up bigger and bigger,
big as a tractor, so big I can smell the machinery
inside the way you smell a motor pulling too big a
load. (11)

The appearance of a mechanical monster like this could easily represent the U.S. government, and especially so when the monster is breaking up a group of black boys. After all, they were in a "group . . . and mumbling together" (10). Maybe they were planning to break out of their subordinate roles as well. The allegory of Kesey's ward draws not only from the posi-

tive breaking out (in his eyes), but also the negative aspects of our society such as racism. It also seems clear that the big Big Chief, whose once untamed native spirit is broken, is not coincidentally submissive to the dominantly bigger Big Nurse. These dimensions in the story add realism to Kesey's allegory and help define Big Nurse's position of power.

Testing the power and authority in Big Nurse's world is the protagonist, Randle McMurphy. From the moment McMurphy enters the ward, he refuses to submit quietly to the ongoing tyranny of Big Nurse: "you never can tell when just that certain one might come in who's free enough to foul things up" (41). From running a card-shark gambling ring among the patients to eventually taking them out on a one-day fishing trip (complete with beer and girls), McMurphy is a constant threat to the consistency of Big Nurse's power hold over the ward.

McMurphy is also a threat to the physical confinement of the ward. In one particular instance, he declares that he could break out of the ward at any time that he wanted. So when the other patients badger him to prove it, McMurphy attempts to pick up a four hundred pound steel and cement panel to throw through the window. Although he is obviously unable to win their bets, McMurphy makes a strong point when he says with bloody hands, "but I tried . . . Goddammit, I sure as hell did that much" (111). From this incident, Kesey seems to indicate that regardless of the outcome, there is value in revolutionary attempts.

With this in his mind, the end of Cuckoo's Nest has much greater meaning. In the final chapter, which begins just after some late night revelry McMurphy planned in the ward, Big Nurse calls in her Trump card and has McMurphy lobotomized. While this dehumanizing action may seem to show that Big Nurse, the combine, and the system have finally won, it proves to be insignificant in the big picture of the ward. For after the surgery, Big Chief realizes that despite McMurphy's pulse, he is already dead. So with a pillow and a brief struggle, Big Chief lets McMurphy finally break out of the system for good. Once this is complete, Big Chief goes to the steal and concrete panel, picks it up, throws it through the window, and breaks out of the ward himself. This resolution to the novel indicates that despite the death of McMurphy, his attempts at revolution had a giant effect on the rest of the ward, so much so, that none of the patients would ever be the same. And Big Chief, who had lain down to the system as a complacent mute, was now free of the ward's restraints on human life.

Just as the fictional ward keeps its patients confined in Cuckoo's Nest, a very real Folsom prison holds Eldridge Cleaver tightly down in his autobiography *Soul On Ice*. In this book, Cleaver describes his experience as black man in prison in the 1960s. As a convicted marijuana user and rapist

(of white women), Cleaver does not fit the typical role of model american. He felt that his abuse of the white woman was "defying and trampling upon the white man's law, upon his system o values" (Cleaver 14), and upon the system itself. But through his struggles with politics, religion, and racism, Cleaver shows a clearly unique view of the 1960s and how he broke out of the role society gave him.

Right from the beginning of Cleaver's letters, which he wrote in 1965 (his last of nine years in prison), it is clear that the social movement which Cuckoo's Nest parallels has escalated to much more serious "breaking out." As a turning point, 1965 marked the beginning of violent protests, the assassination of Malcolm X, and the well-known Watts riots. As on low rider (1960's ghetto youth) in Soul On Ice put it,

They walking in fours and kicking in doors;
dropping Reds [barbituates] and busting heads;
drinking wine and committing crime; shooting and
looting . . . setting fires and slashing tires;
putting an end to that 'go slow' crap and putting
sweet Watts on the map. (27)

This type of revolutionary behavior made it clear that America could no longer deny that the system was faltering. Segments of society were breaking out all over; the black population, the white youth, and female activists were prying at the bars of the system in attempts to reevaluate social norms and expectations. The fact that Cleaver was forced to witness all of this in prison, the most confined space in society, makes his book even more poignant.

Folsom prison, located in Represa (similar to repression) California, acts as a microcosm similar to the ward of Cuckoo's Nest. Complete with a political leader (the warden), an instigator of rebellion (Cleaver's mind), and a general population (the inmates), Folsom reveals a system within the system. Inside this microcosm, Cleaver finds repression not unlike that which McMurphy found in the psychiatric ward. Where McMurphy's individuality was repressed and punishable, Cleaver finds the same. Cleaver states that "individuality is not nourished in prison, neither by the officials nor by the convicts. It is a deep whole out of which to climb" (16). This tool used by the system, suppressing singularity to control the plurality, works in the same way McMurphy says being "kneaded in the nuts" does. In Folsom, Cleaver explains how a man can "end up not knowing who he is;" because without "constant feedback . . . from the number of female heads he turns" (16), a man becomes emasculated by the system.

And as stated earlier, gender can be viewed as the most basic form of individuality. Cleaver goes on to say that one way that the system has kept

"Negroes in optimum subjugation has been a conscious, systematic emasculation of Negro leadership" (87). He defines this emasculation by explaining how Negro leaders are "either cast in prison, killed, hounded out of the country, or blasted into obscurity or isolation" (87). While the context is certainly different, these methods of control begin to sound frighteningly like those used on the American Indian. This minority, as represented by Big Chief in Cuckoo's Nest, has suffered under the system even more than the Negro. Big Chief literally thinks he has shrunk down from his actual massive size due to the machinery of the system. Only with the help of McMurphy's rebellious attitude as an example can Big Chief regain his size and strength. Apparently the system understood this possibility of regeneration, and used all its power to stop any black McMurphys (like Malcolm X) from letting the shrunken Negro psyche out of its prison.

Masculinity also becomes an important issue in yet another microcosm within *Soul On Ice*: the boxing ring. Inside the bar like ropes, sweating, stinking men must use every aspect of their maleness to conquer the opponent. Prior to the "equal" status of black men, this sport was just that, a sport. But once the black man was allowed to compete within the ropes as a equal opponent, the battle in the ring became a symbol for "ultimate masculinity" (86). Cleaver uses the Muhammad Ali-Floyd Patterson fight as an appropriate example of how the system viewed black men. He distinguishes between the two fighters by calling one (Ali) the "black hope," and the other (Patterson) the "white hope" (91). By defining the fighters this way, Cleaver is able to examine the fight on a bigger social level. He views Ali as the "autonomous Negro" who will attempt "to see Uncle Tom defeated," to see Patterson, the 'subordinate Negro,' become a social stigma (91). And Muhammad Ali does win the battle, leaving the system's control in question. But this victory is confined to the bar-like ropes of the boxing ring, and beyond it, into the microcosm, the system still reeks of control.

Despite the system's control over him, Cleaver breaks out of his prison, metaphorically, in several ways. The most obvious of these is writing. As he states at the onset of the book, "that is why I started to write . . . to save myself" (15). By allowing his thought to break out of the confinements of prison life, Cleaver is able to transcend the walls and forget the "rigid, dehumanizing rules" (7). He also uses his writings as a means of self therapy for his "sickness." As Cleaver states, "We are a very sick country, I, perhaps, am sicker than most" (16). His sickness, which caused him to be a rapist, can be defined through his indiscriminate hatred of the white woman. From the most basic excuse, "a black growing up in America is indoctrinated with the white race's standard of beauty" but simultaneously told "look but don't touch" (10), Cleaver was finally forced to admit (of his

rape) that "I was wrong" (15). Through his writing, however, Cleaver begins to reevaluate his hatred, and by the end of the book he redirects his passion to love for the black woman. Although he gives a new philosophy, "put on your crown, my Queen [black woman], and we shall build a new city together in these ruins" (210), Cleaver fails to mention that the woman he loves, his lawyer Beverly Axelrod, is white. While this infuriating hypocrisy seems senseless at first, it truly reveals an even worse horror: the system, despite its faltering, is still in control.

As the 1960s press on, however, this faltering becomes more of a complete shakedown. And right there at the front of it all, shaking crazily at the bars of the system, is the very author of *Cuckoo's Nest*, Ken Kesey and his band of Merry Pranksters (a group of like-minded 1960s youth living with Kesey). In his documentary style book *The Electric Kool-Aid Acid Test*, Tom Wolf follows the Merry Pranksters across the continent on their relentless crusade to reexamine the norms and expectations of American society. From the "Day-Glow" bus trip across the country to the large-scale production of "Acid Tests," Kesey funded one of the most elaborately experimental lifestyles in history.

As a method of reexamination, Kesey and the Pranksters used and advocated drugs (especially LSD), and changed their appearance, and helped bring out new music (the emergence of the Grateful Dead). By using these methods to break out of the system, the Pranksters actively voiced their disapproval of everything the older generations stand for. Their elders, who once advocated the slavery of an entire race, who sent black and white boys to Vietnam to get killed and punished while they kill and punish the same boys right at home, who make laws to keep their position of power intact by weakening others . . . Kesey and the Pranksters represented a desperate need to reassess the system. As Eldridge Cleaver states in *Soul On Ice*,

The white youth of today [1965] have begun to react to the fact that the "American Way of Life" is a fossil of history. What do they care if their old baldheaded and crew-cut elders don't dig their caveman mops? They couldn't care less about the old stiffassed honkies . . . Is it any wonder that the youth have lost all respect for their elders, for law and order. (81)

The most controversial way the Pranksters, and many other kids shortly thereafter, went about breaking out of the social constraints imposed on them was LSD. LSD, acid, acid gets were on to LSD as well. The strange clothes, the weird music (with Kesey's help, the Grateful Dead became the

origin of "Acid Rock"), and the strange dancing were making a huge impact on the system. The police, enforcers of the system, wanted to convict all of them, make them "outlaws," but they couldn't even figure out what it was, much less label it illegal. The system would eventually take care of this with new laws.

The "Acid Tests" and the bus trip, Big Chief busting out of the ward, and Eldridge Cleaver mentally escaping prison are all examples of the need to break out expressed by literature in the 1960s. These works not only give insight into the culturally historical 60s, but they also show a conscious effort to break out of the confinement of language. Kesey, who wrote parts of *Cuckoo's Nest* on acid, showed that his off "dead-center" style could be accepted. He explained to a reporter that "Writers are trapped by artificial rules . . . We are ruled by an imaginary teacher with a red pen" (136). Cleaver also broke form the rules with his work. The simple fact that a black, convicted rapist and drug user could be published and accepted says enough. Even Tom Wolfe's *Acid Test* has countless breaks form proper syntactical and grammatical style, and it is said to be "vibrating dazzle," by the *New York Times*. Certainly all of these works, as well as many others not mentioned here, are direct attempts to unbar the confining world of the system.

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Murray Dunlap is a Junior English major from Mobile, Alabama. He completed this paper as an independent study on literature of the Sixties. He hopes to one day be a professional writer.

ANGIE GODWIN

Physical Attractiveness and College Retention

AMONG THE FACTORS which affect retention in institutions of higher education is physical attractiveness. The relationship between the level of one's physical attractiveness and the likelihood that the individual will be retained until degree completion is an indirect one, with the effect of physical attractiveness being exerted on the student's social integration. The higher the level of a student's physical attractiveness, the more socially integrated the student, and the more likely he or she is to be retained at the institution until degree completion.

An analysis of retention quickly illustrates that there is no single factor which can predict which students are likely to be retained and which are likely to leave their educational institution before degree completion. One characteristic which consistently plays a role in the retention process, however, is institutional integration. Also referred to as "institutional fit," institutional integration is the degree to which a student is connected with, and derives satisfaction from, the life of the college or university, its goals, and its purposes. Previous research has found that academic, social, and financial integration are three aspects of institutional life which do much to clarify the question of retention. After reviewing this literature, I will argue that physical attractiveness is another factor that predicts retention.

FAMILY BACKGROUND

Given these general tendencies, an overview of a student's background allows one to see the substantial role that the family plays in the educational process. As a child's primary agent of socialization, his or her family life does much to predict eventual retention. In evaluating a student's background, the student's sex, as well as the socioeconomic status of his or her family are of primary importance.

The socioeconomic status of a student's family exerts its influence in

a variety of ways. Research has shown that, when compared to lower-class parents, middle-class parents tend to raise their children in ways that foster greater achievement orientation, enhanced sensitivity to others, and superior cognitive abilities. Because these particular characteristics seem to fit well with the expectations of the school, middle-class children are prone to be more successful in school from the very beginning (Kerckhoff 1972).

Social class is important throughout the socialization process. The early advantage that middle-class children have produces a snowball effect as the child continues his or her education. Students who are initially well-equipped to meet the demands encountered at school are rewarded for their successes and provided with additional opportunities to excel. Because the school environment is designed to conform to the past performance of the child, those who begin life in the higher status levels are likely to remain there, while those who begin at the lower levels usually find themselves confined to that socioeconomic class (Kerckhoff 1972).

Aside from the actual characteristics children may acquire as a result of their social class, the expectations which are associated with different classes are influential in shaping a child's educational experience. A school counselor, for example, may encourage a high school senior from a middle-class background to attend college regardless of his or her academic record. The parents of a child from a poor family, however, may caution him or her against having high aspirations (Kerckhoff 1972).

Because family characteristics are often inseparable from other elements of a student's background, some research summarizes the effects of these two factors by saying that, "Children from better social backgrounds do better in school and do better after school" (Coleman 1987). Performance in high school is related to success in post-secondary education. For example, this suggests that a student who has good attendance in high school, earns good grades, and has no disciplinary problems, will be successful in college. Conversely, poor preparation and performance in high school is associated with difficulty in college (Coleman 1987).

The addition of measures of ability, as indicated by ACT test scores, to socioeconomic background provides a more cogent picture of which student groups are likely to be retained until degree completion and which are not. Those with higher ability and higher socioeconomic status are more likely to complete four-year degree requirements within six years than are those at the lower end of each scale. There is a greater difference between completion among the highest and lowest quartiles of socioeconomic status, indicating that individual ability is more closely associated with eventual retention and completion than is socioeconomic background (Tinto 1993).

TABLE 1

Six-Year Persistence Rates for Students Entering Four-Year Colleges Full Time Immediately after High School, by Ethnicity and Socioeconomic Status

----- Completing Degree -----	
Hispanic Students	
Lowest quartile	22.7
Second quartile	32.6
Third quartile	34.4
Highest quartile	22.5*
Black Students	
Lowest quartile	22.8
Second quartile	21.9
Third quartile	32.5
Highest quartile	44.1
White Students	
Lowest quartile	32.5
Second quartile	35.6
Third quartile	50.0
Highest quartile	56.6

Note: An asterisk (*) indicates unweighted N less than 30
Source: Derived from Tinto (1993, table 2.17)

Note: An asterisk (*) indicates unweighted N less than 30
Source: Derived from Tinto (1993, table 2.17)

ACADEMIC INTEGRATION

Academic preparation, as measured by ability and high school performance, is one indicator, albeit weak, of college persistence. A 1966 study found a correlation of 0.34 between high school grade point average and college persistence, indicating that high school grades account for only twelve percent of the variation between completion and departure. Additionally, academic dismissal, which might result from poor study skills and habits, accounts for less than twenty-five percent of all institutional departures (Tinto 1993). Because an analysis of past school performance and common measures of ability leaves the majority of the variation between retention and departure unexplained, we turn to an analysis of other factors which helps account for a student's academic integration.

Incongruence occurs when a person views himself or herself as being substantially at odds with the institution. Naturally, the faculty plays an important role in the student's perception of his or her fit with the institution. Not surprisingly, then, frequent contact with the faculty appears to be among the most important types of contact in predicting student reten-

tion. While the presence of student-faculty interaction which extends beyond the classroom and into social settings is strongly associated with student persistence, interaction which is limited to the traditional classroom setting is associated with institutional withdrawal. Although contact inside the classroom may make further interaction possible, it is the more informal relations which encourage retention (Tinto 1993).

FINANCIAL INTEGRATION

Financial integration is an integral component in retention, as withdrawing students frequently cite finances as an important reason for leaving their institution.

Financial aid given to a needy student upon entry to an institution can have a positive effect on his or her retention. While such aid given after the student enters college has no direct role on persistence, assistance provided at the time of entry may help compensate for the disadvantages of low-income students, thereby making them as likely to persist as higher income individuals who do not receive aid. Not only does financial aid granted at the time of the student's entry alleviate some of the student's financial burden, but it also gives them the freedom necessary to participate in social and academic activities which promote integration into all aspects of institutional life (Tinto 1993).

Scholarships are one form of financial aid which seem to be correlated with increased persistence. Although underclassmen tend to rely on scholarships more than older students, increased rates of persistence at all levels are associated with increased reliance on scholarships. In a 1975 study conducted at Arizona State University, in fact, results indicate that 25.2% of all persisters relied on scholarships while only 14.5% of dropouts did so (Iwai & Churchill 1982).

Several factors may help explain the importance of scholarship money in the question of retention. First, assuming that persisters are more motivated to succeed in school than are other students, this same motivation may encourage them to work toward good grades in order to qualify for, and retain, scholarships (Iwai & Churchill 1982). This explanation finds support in Vincent Tinto, who asserts that high levels of educational and career plans are influential in causing the student to remain in college. Because persisters are more committed to their educational experience than are withdrawers, they may seek out more sources of financial support in order to complete college (Tinto 1993). As an added benefit parents may be more likely to lend financial assistance to a child who is motivated to succeed than to one who is unmotivated. The motivated student, then, may

receive two financial rewards by virtue of his or her motivation: scholarship money and parental support (Iwai & Churchill 1982).

SOCIAL INTEGRATION

A student's family background, academic integration, and financial integration combine to influence his or her social integration. Social isolation, or the lack of sufficient contact between the individual and other members of the institution's community, is also tied to departure. Research indicates that socially isolated individuals who leave differ from those who persist in only one characteristic: they have failed to form a significant personal connection with either a student or faculty member on campus (Tinto 1993).

"Student subcultures," which describe the diversity of student communities on campus, do much to define a student's level of social integration. While a student may be at social or intellectual odds with the majority of students at his or her institution, it is still possible for him or her to find the support necessary for continued persistence. Finding one's niche within the college community, then, is virtually a requirement for retention. Though membership in a particular subculture does not ensure persistence, the absence of such membership does seem to exert a negative impact upon retention (Tinto 1993).

Although social integration is related to group attachment, institutional persistence is also dependent upon the type of group in which the student holds membership. The closer the student is to the mainstream of the social life of the college, the more likely he or she is to perceive himself or herself as being in congruence with the institution as a whole. Conversely, the more marginal one's interaction is to the center of the institutional life, the more likely one is to perceive him- or herself as separate from the institution. Therefore, while a student may have strong ties to a particular student subculture, if that subculture lacks strong attachment to the institution, the individual student's attachment to the institution may be weak (Tinto 1993).

As noted above, factors which pull a student away from the center of institutional life hinder persistence. External obligations, then, are important components in predicting retention. Employment, perhaps the most common example of an external obligation, is negatively related to institutional persistence. The time commitment and demands of one's job often preclude participation in college-related extracurricular activities. By restricting a student's opportunities for contact with both faculty and other students, employment weakens both social and academic integration (Tinto 1993).

PHYSICAL ATTRACTIVENESS

Much literature on physical attractiveness addresses the issue of the "attractiveness stereotype," which describes the differential treatment of attractive and unattractive individuals. The attractiveness stereotype asserts that society attributes more positive or desirable traits to attractive people than to unattractive people (Sabini 1992). Expectations which are then based on these attractiveness stereotypes may become self-fulfilling prophecies for the individual. The reactions that attractive people get, for example, helps them become more socially adept. Attractive individuals, then, receive positive reinforcement in two ways: not only are they perceived as being good-looking, but they also acquire additional social skills (Umberson & Hughes 1987).

Goldman and Lewis's study of telephone conversations between pairs of opposite sex college students supports the physical attractiveness stereotype. The students rated their partners, whom they could not see, for social skill, liking, anxiety, and desirability for future interaction. As expected, the more physically attractive students were rated by their partners as being more socially skilled and likable than the less attractive partners. It seems, then, that there is at least some truth to the claim that people are likely to ascribe qualities such as intelligence and friendliness to the physically attractive (Goldman & Lewis 1977).

Assuming the existence of an attractiveness stereotype, attractive people are provided with more opportunities to be successful. This phenomenon is evidenced in the classroom, for research demonstrates that attractive children receive more instructional attention than do unattractive children. If such a pattern were to continue throughout a student's educational career, one can see how an attractive student could attain higher grades, stronger ties with the faculty, admission to a better college, and a more lucrative first job than an unattractive student. All else being equal, then, this finding suggests that an attractive person should surpass an unattractive person in education, occupational prestige, and income (Umberson & Hughes 1987).

Some evidence, in fact, indicates that attractive children receive significantly higher report card grades than their unattractive counterparts. In one study directed at defining this relationship, teachers were given identical report cards with different photographs attached to them and asked to judge which children were more intelligent; as expected, the more physically attractive students were judged to be more intelligent. One explanation for this occurrence may be that the report card grades reflect the biases of the teachers instead of the student's actual performance. In addition,

report card grades may reflect the school's curriculum instead of the child's ability (Salvia, et al. 1977).

Some research on the relationship between achievement and physical attractiveness, however, refutes the self-fulfilling prophecy in favor of the compensatory hypothesis. Moran and McCullers found that less attractive high school students scored significantly higher on eighth-grade IQ tests and twelfth-grade ACT tests than did more attractive individuals. Such studies suggest that to the extent unattractive people have a low social self-image, they will attempt to compensate by doing better academically and thereby having a positive academic self-image (1984).

While suggesting a relationship between attractiveness and achievement, research conducted at the college level refutes the compensatory hypothesis. The findings of a study conducted at a small women's college indicate that physical attractiveness did not directly affect the grading in business courses at this institution. Attractive students did not receive higher grades; attractiveness seemed to be of no special benefit to those with lower abilities. Again, unattractive students at this institution may have attempted to compensate for their appearance by striving to earn high grades (Baugh & Parry 1991).

Research conducted by Udry and Eckland also suggests that physical attractiveness plays an indirect role in achievement. Findings for both males and females show inverse correlations between attractiveness and college grades. For females, physical attractiveness is tied to the characteristics of their family. Highly attractive females tend to come from families in which the father has more education, higher income, and higher job status; this, however, is not the case for males. These relationships may have an impact on both achievement in college, and marital and socioeconomic status after college (1984).

HYPOTHESIS

Physical attractiveness is one of the factors which predicts retention in institutions of higher education. The level of a student's physical attractiveness affects his or her social integration, which, in turn, exerts an impact upon eventual retention. The relationship between attractiveness and retention, then, is an indirect one, with highly attractive students being more likely to be retained due to their greater peer group involvements.

METHODOLOGY

The data for this study is based on information gathered from 331

undergraduate students at a small, liberal arts college in the southern United States. All students included were part of the entering class of 1985. Data were gathered from college records, surveys of students, and college yearbooks. Students whose pictures did not appear in the yearbook were excluded from the analysis, leaving a net sample of 267.

The variable used to measure retention is RETAIN. This variable distinguishes those students who dropped out of school (coded 0) from those who graduated (coded 1).

Three measures of students' family background are included: the student's sex, marital status of the student's parents, and the socioeconomic index score of the student's father. SEX is coded 0=female and 1=male. DIVORCE, the variable for the marital status of the student's parents, is also a dichotomy: 1=divorced and 0=married, widowed, etc. The socioeconomic status of the student's father, FSEI, is Duncan's (1961) socioeconomic index for occupations. Information for these family background variables was obtained from a written survey answered by the student, the student's parents, or both. When this survey was not available for a particular student, the father's occupation was secured from a city directory.

Measures of academic integration include the student's high school grade point average, HSGPA, and ACT test score, ACTTEST. The lowest high school grade point average appearing in this study is 1.70, with the highest being 4.0; the lowest ACT score is 14, while the highest is 33.

LGMONEY represents financial integration and is the natural log of the amount of college scholarship money the student receives. The natural log is used in order to correct for skewness. While some students in this study received no scholarship money, others received as much as \$25,000.

The student's social integration is measured by his or her Greek status. GREEK indicates whether or not a student is a member of a fraternity or sorority, with those holding membership

in a Greek organization being coded as 1 and those not belonging to such an organization being coded as 0. Greek affiliation was selected as a measure of social integration because membership in a fraternity or sorority provides opportunities for both frequent and extensive social interaction, often with members of the opposite sex. This is a particularly useful measure of social integration at the institution in this study, for the majority of its undergraduate students are members of Greek organizations.

ATTRACTIVE is the variable used to measure a student's level of physical attractiveness. The students in a sociology course were asked to use yearbook photographs to rate the attractiveness of the students in this analysis from 1=very unattractive, to 5=very attractive. The ratings were determined by averaging the scores assigned to each student.

DATA ANALYSIS

Table 2 and Table 3 show the means and standard deviations, as well as the correlation matrix, for the variables used in the analysis. Table 4 shows that physical attractiveness is positively related to retention ($b=0.53$), though it is only marginally significant ($p=0.19$). The second model (Table 5) includes other family background factors. Here, the effect of physical attractiveness decreases: $b=0.043$ at the 0.29 significance level. The father's socioeconomic index explains much of this decrease because physical attractiveness is positively related to FSEI ($b=0.005$, $p=0.03$).

TABLE 2: DESCRIPTION OF VARIABLES

Variable	Mean	Std Dev	Min	Max	N	Label
RETAIN	.76	.43	0	1	268	retention of class of 1985
SEX	.53	.50	0	1	268	sex of student
FSEI	70.15	17.89	11.00	96.00	268	father's SEI score
DIVORCE	.16	.37	.00	1.00	268	parent's marital status
ACTTEST	24.94	3.57	14.00	33.00	268	ACT test score
HSGPA	3.13	.63	1.70	4.00	268	high school gpa
LGMONEY	2.41	3.45	.00	10.13	268	log of scholarship money
GREEK	.73	.44	.00	1.00	268	Greek status
ATTRACTIVE	2.84	.65	1.36	4.57	268	physical attractiveness

TABLE 3: CORRELATIONS

	RETAIN	SEX	FSEI	DIVORCE	ACTTEST	HSGPA	LGMONEY	GREEK	ATTRACTIVE
RETAIN	1.0000	-.0058	.1104	.0120	.1882*	.2086**	.1739*	.1739*	.0811
SEX	-.0058	1.0000	.0663	-.0837	.0481	-.2058**	-.0731	-.1537	-.1106
FSEI	.1104	.0663	1.0000	-.0561	.1106	-.0191	.0554	.0257	.1313
DIVORCE	.0120	-.0837	-.0561	1.0000	-.0137	-.0249	-.0125	-.0950	-.0622
ACTTEST	.1882*	.0481	.1106	-.0137	1.0000	.4943**	.4265**	-.0597	-.1174
HSGPA	.2086**	-.2058**	-.0191	-.0249	.4943**	1.0000	.3604**	-.0407	-.1097
LGMONEY	.1739*	-.0731	.0554	-.0125	.4265**	.3604**	1.0000	-.0693	-.0565
GREEK	.1739*	-.1537	.0257	-.0950	-.0597	-.0407	-.0693	1.0000	.2612**
ATTRACTIVE	.0811	-.1106	.1313	-.0622	-.1174	-.1097	-.0565	.2612**	1.0000

2-Tailed Significance: *-.01 **-.001

TABLE 4: MULTIPLE REGRESSION - ATTRACT

Variable	B	SE B	Beta	T	Sig T
ATTRACT	.052904	.039883	.081063	1.326	.1858
Constant	.610943	.116229		5.256	.0000

TABLE 5: MULTIPLE REGRESSION - FAMILY BACKGROUND

Variable	B	SE B	Beta	T	Sig T
SEX	-.003527	.052844	-.004130	-.067	.9468
FSEI	.002454	.001480	.102754	1.658	.0986
DIVORCE	.015285	.070840	.013281	.216	.8293
ATTRACT	.043258	.040622	.066284	1.065	.2879
Constant	.465569	.150246		3.099	.0022

TABLE 6: MULTIPLE REGRESSION - ACADEMIC INTEGRATION

Variable	B	SE B	Beta	T	Sig T
SEX	.028605	.053484	.033500	.535	.5932
FSEI	.002101	.001456	.087986	1.443	.1502
DIVORCE	.022025	.069064	.019137	.319	.7500
ACTTEST	.012050	.008425	.100657	1.430	.1538
HSGPA	.121085	.048327	.179200	2.506	.0128
ATTRACT	.067538	.040029	.103488	1.687	.0928
Constant-	.275767	.242798		-1.136	.2571

TABLE 7: MULTIPLE REGRESSION - FINANCIAL INTEGRATION

Variable	B	SE B	Beta	T	Sig T
SEX	.032742	.053496	.038345	.612	.5410
FSEI	.002046	.001454	.085675	1.407	.1607
DIVORCE	.022649	.068965	.019679	.328	.7429
ACTTEST	.008475	.008832	.070791	.960	.3381
HSGPA	.110025	.048967	.162832	2.247	.0255
LGMONEY	.011062	.008319	.089226	1.330	.1848
ATTRACT	.067897	.039971	.104037	1.699	.0906
Constant-	.178132	.253316		-.703	.4826

The next model (Table 6) controls for both family background and academic integration (ACTTEST and HSGPA). The results show that academic integration suppresses the relationship between attractiveness and retention. Taking these two variables into consideration, the *b* for ATTRACTIVE increases to *b*=0.068, *p*=0.09. For every one unit increase in attractiveness, a student's retention rate is expected to increase by 6.8%. This suppressing relationship is due to the negative effect of attractiveness on academic integration. Net of family background, there is a negative relationship between ATTRACTIVE and both ACTTEST and HSGPA; for ACTTEST, *b*=-0.716 with *p*=0.03 and for HSGPA, *b*=-0.129 with *p*=0.03. These results support the compensatory hypothesis.

Adding financial integration (Table 7) does little to predict retention, though its effect is in the expected direction. For LGMONEY, *b*=0.011 and *p*=0.18. Because financial integration neither predicts social integration, nor is predicted by ATTRACTIVE, it has no bearing on retention via physical attractiveness.

The final model (Table 8) includes social integration, which proves to be the most significant predictor of retention. GREEK status is an important intervening variable (*b*=0.182, *p*=0.00). Students who joined Greek organizations as freshmen were 18.2% more likely to graduate than those who did not join. This variable also explains much of the effect of attractiveness on retention found earlier. When GREEK is included, the effect of ATTRACTIVE on RETENTION is reduced 50%, from *b*=0.067 to *b*=0.037.

Attractiveness, in fact, accounts for over 10% of the variance in Greek status ($R^2=0.104$). Net of family background, and academic and financial integration, ATTRACTIVE is a significant predictor of GREEK ($b=0.168$ and $p=0.00$). This finding establishes the link between attractiveness, social integration, and retention. High physical attractiveness is predictive of social integration, which, in turn, predicts retention.

CONCLUSION

This research begins to uncover the role that physical attractiveness plays in predicting college retention. Because the effect of attractiveness is exerted through social integration, as measured by membership in a sorority or fraternity, it should be noted that the majority of undergraduate students enrolled in the institution at which this research was conducted were members of such Greek organizations. Realizing that it may be appropriate to use an alternate measure of social integration for campuses with smaller Greek populations, it would be interesting to see if future studies conducted in such environments replicate these results.

Because the two measures of academic integration, ACT test scores and high school grade point averages, indicate the student's performance prior to college entrance, they may not accurately reflect his or her current level of academic integration. Also, the inclusion of additional factors in the measure of physical attractiveness, such as the subject's weight and whether or not he or she wears glasses, might serve to clarify the relationship between physical attractiveness and retention.

TABLE 8: MULTIPLE REGRESSION - GREEK STATUS

Variable	B	SE B	Beta	T	Sig T
SEX	.056798	.053244	.066519	1.067	.2871
FSEI	.002060	.001432	.086280	1.439	.1513
DIVORCE	.049710	.068460	.043190	.726	.4684
ACTTEST	.008042	.008694	.067176	.925	.3558
HSGPA	.114363	.048221	.169253	2.372	.0184
LGMONEY	.012550	.008203	.101227	1.530	.1273
GREEK	.181748	.059477	.188955	3.056	.0025
ATTRACT	.037337	.040596	.057211	.920	.3586
Constant-	.248733	.250418		-.993	.3215

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Angie Godwin is a Senior political science/sociology major from Ozark, Alabama. She completed this paper as a final project in her sociology Senior Seminar. Although Angie plans to someday attend law school, she will be spending next year combining her two loves: travel and learning.

SETH RAYBURN

*Conceptualizing Time Dilation:
A Contemporary Explanation of the
Einstein Theory of Special Relativity*

"**N**EWTON, FORGIVE ME." —Albert Einstein,
on talking about relativity (qtd. in Gardner 1976)

FOREWORD

This paper is presented to provide an understanding of the unusual but fascinating concept of time dilation. The writing style of this paper is aimed toward readers who have an interest in the Special Theory of Relativity but are not interested in the complete mathematical derivations involved with Einstein's original work. Some basic trigonometric and physical concepts are included in this short paper in order for the reader to better comprehend relativistic phenomenon. Most of the reading should be easy, yet it is advised that the reader proceed slowly through the innovative physical concepts. In the words of Einstein, "May this [paper] bring someone a few happy hours of suggestive thought" (Einstein 1921).

ABSOLUTE VERSUS RELATIVE

Two exploring scientists, Stan and Dan, were desperately searching for a crystal of a rare-earth-transition metal that could only be found deep in the heart of a secluded New Mexican desert. After roaming for five days in nothing but horizons and horizons of sand, Stan suddenly notices an extremely large Gila Monster resting on an enormous sand dune nearby.

"Hey Dan, look at that lizard!" Stan shouted. "We've shrunk!"

There is a lesson to be learned from this comical situation. There is no way of judging the size of an object except by comparison with another

object. The size of a period on this page is extremely small in comparison with the size of the earth, yet the same period is extremely large in comparison with the size of an individual proton.

In view of relativity, there is no absolute size of anything—only a relative size to something else. If we were to say that the size of an object were, for example, 5 centimeters, even then we would be relating the size of the object with the size of the graduations on a ruler.

The same relativity holds true for periods of time. To a student listening to a boring lecture, one minute may seem to last an exceedingly long time; however, to a geologist who is studying the age of land masses, one minute may seem entirely negligible. In fact, the speed of any moving object or the distance it travels is relative to other objects—except in one unique circumstance. The speed of light, as we shall see, always remains an absolute constant. Perhaps Einstein should have titled his work on relativity “The Theory of Non-Relativity of Light,” instead of “The Theory of Relativity.”

A New Understanding of Physics

Realizing meaning out of basic mass, space, and time, Isaac Newton in 1687 presented his renowned laws of mechanics. These laws fabricated the foundation of motion with clear mathematical rules accounting for acceleration, momentum, force, and energy (Han 1993). According to *Newtonian Relativity, the laws of mechanics are the same in all inertial frames of reference*. An example of an inertial frame could be the inside of a car, while another simultaneous inertial frame could be the street. If Dan, who happens to be standing still on the edge of the street, were to toss a ball into the air, then Stan, who happens to be in the passing car of known velocity, could use Newton’s laws of motion to calculate the velocity of the ball as it left Dan’s hand. An important attribute of Newtonian Relativity is that time is assumed to be the same in both inertial frames of reference.

Newton’s laws of classical mechanics were tested and utilized constantly and without limitation for almost 300 years. His laws held completely and universally for visualized motion and electromagnetics alike, and some scientists speculated that the subject of physics was becoming a completely accomplished matter (Han 1993). To give one example, toward the end of the 19th century the European physicist Emil Du Bois-Reymond wrote that science had at last come up against unbreakable barriers of understanding, beyond which we shall always remain ignorant (Holton 1993). Yet, in 1905, at the age of only 26, a spare-time physicist who worked in a patent office in Switzerland published four scientific papers that revolu-

tionized physics. The most important paper in terms of contribution to modern physics was his special theory of relativity (Serway 1990).

Classical physics came to an abrupt end as Einstein revealed his discovery that space and time were not separate entities. He single-handedly built a new framework of motion and mechanics, with innovative rules for velocity, acceleration, momentum, force, and energy (Han 1993). Einstein did not discredit the laws of Newton. He simply expanded them to include all valid velocities from absolute zero up to the speed of light. It was only when velocities approached the speed of light that the laws of classical physics failed.

THE THEORIES OF LUMINIFEROUS ETHER

In the case of mechanical waves, such as water or sound waves, there has to be a medium in which the wave can cause a disturbance. In the 19th century, physicists thought that electromagnetic waves (i.e., light waves) behaved in the same manner, and therefore also required a medium through which to propagate. Scientists proposed that such a medium existed, and they labeled it luminiferous ether (Serway 1990). In addition, they proposed that ether had an unusual property of being massless but rigid, and did not affect the motion of objects or planets.

Michelson and Morley Experiment

Because of the importance and pervasiveness of ether, A. A. Michelson and E. W. Morley set out in 1887 to prove that ether existed (Lilley 1981). They attempted to use a method that would measure the influence of ether flow upon the speed of light relative to earth (Michelson and Morley 1887). For instance, if v were the velocity of Ether, then the speed of light c should have its maximum value, $c + v$, when moving downwind with ether (see the vector addition in figure 1a below). Likewise, the speed of light should have its minimum velocity, $c - v$, as it traveled upwind to ether (figure 1b). If light were to travel across the ether wind, then the resulting velocity would hold true to the Pythagorean theorem or basic trigonometry in being $(c^2 - v^2)^{1/2}$ (figure 1c).

SEE FIGURE 1.

To summarize the workings of a complex experiment, Michelson and Morley created an apparatus called an interferometer (Michelson and Morley 1887). In the interferometer, a light source passed through a beam splitter that resulted in casting two perpendicular beams of light onto respective mirrors (see figure 2 below). The beams of light were then bounced back to

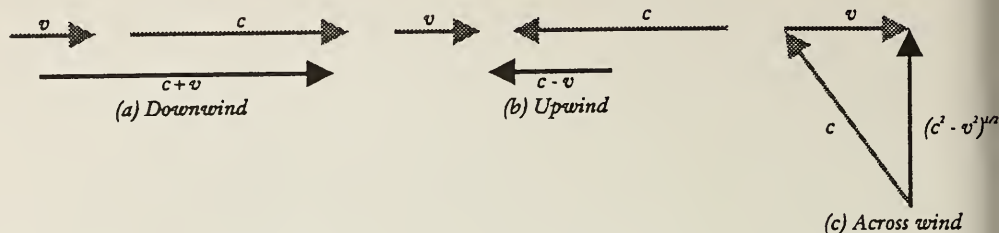


FIGURE 1.

the original point where they were made to interfere with each other (Rindler 1982). The entire apparatus was rotated throughout 360 of motion in order to observe different interference patterns as the speed of light was altered by the velocity of the ether wind. As the beams of light were simultaneously cast, mathematics predicted that the round trip travel time of the light beam perpendicular to the wind would be longer than the round trip travel time of the light beam parallel to the wind. The difference in travel times of the "arms" of light would create an alternating pattern of light and dark bands when the light beams returned to the original point. By measuring the bands, the time of travel of light with the ether wind and the time of travel of light across the wind could be quantitatively compared, and the velocity of the ether wind could ultimately be calculated.

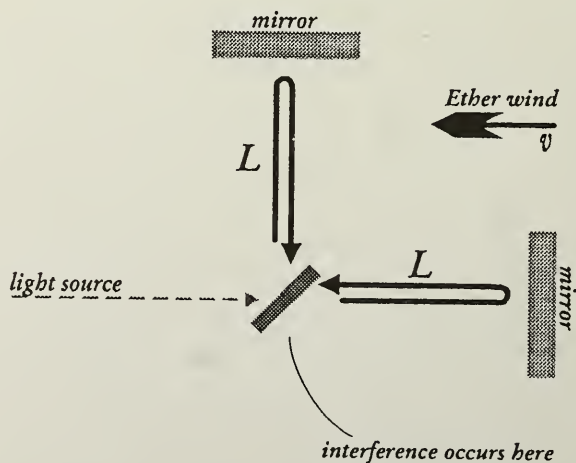


FIGURE 2.

Now we shall view the math behind the experiment.

First of all, remember that time, t , is length, L , divided by velocity, v . The velocity of light is defined as c , and the velocity of ether is v . If we examine the light parallel to the ether velocity, then the time it takes for light to travel out and then back in would be:

$$t = L/(c - v) + L/(c + v) = 2L/c (1 - v^2/c^2)^{-1}$$

Next, consider the round trip of light perpendicular to the ether wind. In this case, the speed of the beam relative to earth is $(c^2 - v^2)^{1/2}$. Each half trip is $L/(c^2 - v^2)^{1/2}$, and the total round trip time for the perpendicular arm would be:

$$t = 2 * [2L/(c^2 - v^2)^{1/2}]$$

Thus, it would take longer for the latter round trip.

The difference between the two round trips would result in a measurable phase difference between the light beams, thereby revealing the alternating bands. However, much to the amazement of Michelson and Morley, no bands were visualized! In other words, **no difference in the speed of light was observed** due to the velocity of the ether wind. Since then, the experiment has been repeated by recent scientists under various conditions, and no shift in light bands has ever been detected (Serway 1990).

To Michelson and Morley, their experiment was regarded as an unexplained failure. In retrospect, only one scientist was on the right track of interpreting the results—H. A. Lorentz, who proposed that the length of an object moving along the flow of ether would contract by a factor of $(1 - v^2/c^2)^{1/2}$. In other words, he thought that the ether wind somehow distorted "true" length and time.

As it turned out, no "failed" experiment advanced physics so much. The experiment set the stage for the brilliant young Einstein to do away with the concept of luminiferous ether altogether and to explain the experiment with his special theory of relativity, which we shall soon see (Einstein 1921, Serway 1990).

Relativity of Simultaneity

Albert Einstein suggested that there was no error in the experiment, and he arrived at two postulates (Serway 1990):

- (1) All the laws of Physics are the same in all inertial reference frames.
- (2) The speed of light *in vacuo* [vacuum] has the same value, $c = 3.00 \times$

10^8 m/s, in all inertial reference frames.

The first postulate is just a generalized restatement of Newton's law of relativity mentioned earlier. The second statement implies that anyone who measures the speed of light will arrive at the same value, regardless of that person's movement. Now that the postulates have been presented, let's examine the consequences of these postulates in the phenomenon of simultaneity.

Einstein devised an illustration of a train boxcar moving near the speed of light to examine simultaneity (Einstein 1921). A person in the train would regard everything in reference to the train, while a person on the embankment would regard everything in reference to the embankment. For instance, if a train passenger were to drop an object out the window, then the object would appear to the passenger to travel vertically down to the ground. However, to an observer standing on the tracks, the same object thrown out the window would appear to travel in an arc until it reaches the ground. The definition of simultaneity can also be given in reference to the train or in reference to the embankment (Einstein 1921).

Imagine again an observer, O, next to the train track. At a certain distance down the track is point A; at the same distance up the track is point B. Lightning happens to strike simultaneously at points A and B. The observer knows that the events occur simultaneously because he is the same distance from both flashes, and he sees the flashes at the same instant.

Now assume that when the lightning strikes, a train moving near the speed of light travels in the direction of A to B. At the instant the flashes occur, an observer on the train, O', is exactly opposite the observer on the track. Since O' is moving toward flash B and away from flash A, flash B will reach the observer before flash A. As a result, the flashes will not be simultaneous to O'; he will see the flash B before flash A. After all, the light from flash B would not have to travel as far as the light from flash A to reach O' due to the movement of the train. Recall that the same two flashes were simultaneous to the observer standing on the track.

In the same respect, flashes that occur simultaneously to O' would not occur simultaneously to O. If the flashes occur simultaneously to the train, then the stationary observer would see the flash at point A before the flash at point B. We are driven to conclude that there is no *absolute* simultaneity. The only simultaneous events occur relative to a frame of reference. In this example, the frame of reference is either the moving train or the track. In synopsis, simultaneity always depends upon the state of motion of the observer.

A physicist Martin Gardner writes that "the breakdown in the classical notion of absolute simultaneity is by all odds the most beautifully unex-

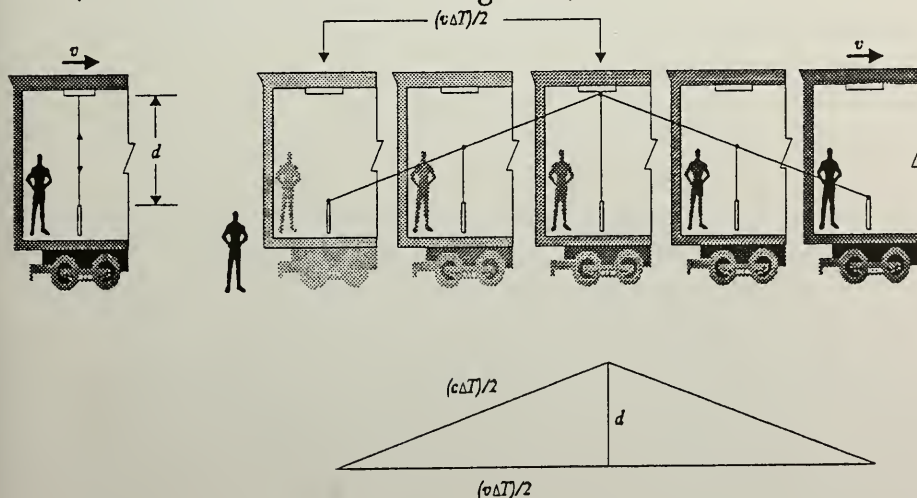
pected aspect of the special theory of relativity" (Gardner 1976). The result of relative simultaneity shows the central point of relativity—any uniformly moving frame of reference can be used to describe events and will hold true to the laws of physics (Serway 1990). If light travels the same speed always, then time and distance are relative to motion. Because simultaneity appears differently, time would appear differently to the observer on the train and to the observer on the tracks. Confused yet? The next section will explain this in new light (no pun intended).

THE DILATION OF TIME (FINALLY)

To prove that different inertial frames will always measure different time intervals between two events, we shall go back to those great scientists Stan and Dan (example modified from Serway 1990). Stan is traveling in a boxcar close to the speed of light. Dan is standing next to the track. Stan holds a unique laser that is capable of emitting a single but highly visible photon of light. There is a mirror on the ceiling of the boxcar at a distance d above the laser. Stan fires a photon of light vertically from the laser (event 1), and after reflecting off the mirror, the photon lands exactly back into the laser (event 2). Stan carries a clock which he uses to measure the time interval t' between the two events. Because the light pulse has a speed c , the time it takes the pulse to make a round trip is found from the definition of velocity:

$$\Delta t' = \frac{\text{distance traveled}}{\text{velocity}} = \frac{2d}{c}$$

(See the boxcar on the left of figure 3.)



Now consider the same two events (photon being fired and photon "landing" back in the laser) as viewed by Dan, who is watching from a stationary frame—the tracks. According to Dan, the laser and the mirror are moving to the right with an ultra high speed v . By the time the light pulse reaches the mirror, the mirror itself has moved a distance $v(T/2)$, where T is the time it takes for the photon to make a round trip to the mirror and back. Because of the speed of the train, Dan sees the photon travel at an angle respective to vertical as it travels to the mirror and then an opposite angle as it reflects back to the laser. (See the 5 boxcar images in figure 3.) Because the path, as seen by Dan, is at an angle, then the photon appears to travel a longer path than seen by Stan. The photon appears to travel a round trip distance of ct for Dan and $2d$ for Stan.

To obtain a relationship between the two time intervals seen by Stan and Dan (t' and T respectively), we apply the Pythagorean theorem to the two adjacent right triangles shown in figure 3. This gives:

$$[(c\Delta T)/2]^2 = [(v\Delta T)/2]^2 + d^2$$

Solving for ΔT gives:

$$\Delta T = \frac{2d}{(c^2 - v^2)^{1/2}} = \frac{2d}{c[1-(v^2/c^2)]^{1/2}}$$

Now because $2d/c = \Delta t'$, we can express the above equation as:

$$\Delta T = \frac{\Delta t'}{[1-(v^2/c^2)]^{1/2}} = \gamma \Delta t'$$

In this equation, $\gamma = (1 - v^2/c^2)^{-1/2}$. The two events observed by Dan occur at two different positions. From the last equation above, we see that the time interval T measured by Dan in the stationary frame is *longer* than the time interval t' measured by Stan in the moving frame (notice that γ is greater than unity). That is $T > t'$. In other words, according to a stationary observer, a moving clock runs slower than an identical stationary clock. This effect is known as **time dilation**.

One more note is in order at this time. In order to measure the two events, Dan must have two synchronized clocks (Lilley 1981). The first clock should be adjacent to where the photon is fired; the second clock should be adjacent to where the photon "lands". If Dan were to use just one clock, then extra time would lapse before the light of the photon would reach him

and his clock. Dan could also use mathematics involving to calculate the time of the second event from the first clock, but this will not be discussed for now.

We have now seen that moving clocks run more slowly by a factor of γ^{-1} . As incomprehensible as it may seem, this will hold true for mechanical clocks as well as for the light clock just described (Serway 1990). We can generalize these results by stating that all physical processes, including chemical reactions and biological processes, slow down relative to a stationary clock when they occur in a moving frame (Serway 1990). For example, if an astronaut were moving in space, then his bodily processes and his clock would all be slowed down relative to earth. The astronaut would not have any sensation of his life or clock slowing down. Upon his arrival back on earth, it would seem to the astronaut that life on earth had sped up while he had been gone.

PROPER VERSUS IMPROPER TIME

Out of convenience, names have been assigned to the different frames of reference when describing time dilation. The proper time between two events is the time between them as measured by an observer in steady motion with both events (Lilley 1981). The time according to any other observer who is not in direct motion with the events is called an improper time. We then see that Dan measures an improper time, while Stan, on the train, measures the proper time. An improper time is always greater than the proper time (Lilley 1981). The rising effects of time dilation in comparison with speed are shown in the table below (Han 1993):

Percentage of the speed of light	Percentage of time dilation
0.01%	0.0000005%
0.1%	0.00005%
1%	0.005%
10%	0.5%
50%	15%
80%	67%
87%	100%
90%	230%
99.5%	1000%

Documented Examples of Time Dilation

Time dilation is a very real phenomenon that has been observed and confirmed experimentally. One such experiment was carried out by D. H. Frisch and J. H. Smith in 1963. This experiment involved muons, which are unstable particles produced by the absorption of cosmic radiation high in the atmosphere. They have a mass of 207 times that of an electron, and have speeds between .9950*c* and .9954*c* (Frisch and Smith 1963). These unstable particles have a lifetime of only 2.2s when measured from a reference frame at rest (i.e., Earth). If we assume they have a lifetime of 2.2s and a velocity close to the speed of light, we find that muons would be capable of traveling only 600m before their decay, and hence would not be capable of reaching the surface of the earth (Serway 1990, Rindler 1982). (The distance was calculated from $d=.99ct$.) However, experiments show that large numbers of muons do reach the earth. The occurrence of time dilation explains this fact. Relative to an observer on earth, the muons would have a lifetime equal to t , or 16s. The distance would be equal to .99*ct*, or 4800m, thus allowing the muons to reach the surface of the earth (Serway 1990).

As amazing as it may seem, time dilation has also been directly observed with macroscopic scale clocks. In October 1971, Hafele and Keating first produced direct evidence of time dilation by employing four very accurate cesium beam clocks on board a number of commercial jet liners which crossed the world (Hafele and Keating 1972). In their paper, Hafele and Keating report the following:

Relative to the atomic time scale of the U.S. Naval Observatory, the flying clocks lost 59 ± 10 ns during the [25 hour] eastward trip and gained 273 ± 7 ns during the [25 hour] westward trip. . . These results provide an unambiguous empirical resolution of the famous clock paradox with macroscopic clocks. . . There seems to be little basis for further arguments about whether clocks will indicate the same time after a round trip, for we find that they do not.

—Hafele and Keating 1972

Conclusions on Einstein's Theories

By addressing time dilation, only one aspect of Einstein's special theory of relativity has been covered. In addition to time, other physical properties are also changed by the factor as their inertial frame of reference approaches the speed of light. For instance, as the speed of light is approached, mass and momentum are magnified as measured from an im-

proper frame, and length is contracted as observed from an improper frame. Because the same speed of light is observed from all reference frames, Einstein equalized mass and energy in his famous equation, $E = mc^2$ (Hawking 1988).

Einstein also arrived at the conclusion that nothing may travel faster than the speed of light. If an object were to actually travel the speed of light, then its mass would become infinite. In addition, it would take an infinite amount of energy to get it to the speed of light. Therefore, only light, because it has no intrinsic mass, can move at the speed of light (Hawking 1988). According to the factor, if the speed of light were actually reached, time dilation would be infinite. In other words, time would stop. A science-fiction writer would love to speculate on what astronauts might observe from a ship exceeding the speed of light. Perhaps stars would acquire negative mass and cosmic time would run backward (Gardner 1976). Mathematically, Einstein's formulas would give value to imaginary numbers.

Despite its universality, there are some physical limitations to the Special Theory of Relativity. These limitations involve gravity. In 1915, Einstein published a new theory, what we now call the General Theory of Relativity, which accounted for gravity. In his General Theory, Einstein proposed the bending of electromagnetic waves (i.e., light) as they approached "waves" of gravity. If we use a flat diagram to represent space and time, then gravity would act to bend the diagram and alter the coordinate system used. Einstein used his General Theory to explain the slight modifications of each revolution of Mercury around the Sun. To put it in geometrical terms, he explained why the planet's closest approach to the sun in the perihelion path advances a few ten-thousandths of a degree each revolution (Conlan 1991).

Despite the fact that Einstein's Theories have originated during this century, scientists are already applying Einstein's work in scientific areas such as nuclear physics, particle physics, and cosmology. Navigational satellites utilize the concepts of time dilation in order to pinpoint areas on earth or to pinpoint the location of traveling space vehicles (Ed. Conlan 1991).

Both the Special and General Theories of Relativity are difficult to conceive because they play against our intuition and experience. Most of us still abide by the rules of Newtonian physics in all practical circumstances. Unless we have access to a particle accelerator, we do not have an opportunity to move anything to a significant fraction of the speed of light. For almost all of our experiences, speeds are incomparably slow to the currently reliable value of $299,792,456.2 \pm 1.1$ meters per second that light travels (Han 1993). Frisch and Smith point out that an ordinary wristwatch on a man walking by a stationary observer loses only about a second every *billion*

years (Frisch and Smith 1963). Even mach one is a meager one-millionth the speed of light (Han 1993). It is true that time dilation is a commonplace event for particle physics. As far as our own experiences are concerned, however, this phenomenon remains almost as bizarre and inconceivable as it did when it was first realized 90 years ago. Yet, as more discoveries and uses of modern physics continue to emerge, perhaps in the future the physics of Einstein will seem as commonplace as Newton's Laws of Motion seem today.

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Illustrations by Mirjana Paukovic

Seth is a Senior chemistry major-music minor from Fayette, Alabama. He wrote this article for his 1995 Interim project. Seth is interested in jazz, calligraphy, music composition, and pyrotechnology. He will be attending medical school at the University of South Alabama next year.

TORY C. SIMPSON

Women in the Civil Legislation of the French Revolution

MANY CONSIDER FRENCH Revolutionary law as a giant step towards equality for the eighteenth-century woman. One important aspect of the Revolution was the effort of the French to rewrite legislation according to Enlightenment ideals. Although this legislation was rather short-lived - passed during the early 1790's and repealed as the momentum of the Revolution staved in the later 1790's, and ultimately replaced by the Code Napoléon passed in 1810 - in many ways it was progressive. Revolutionary law treated the woman directly. Steps toward equality were taken in revisions of the law of marriage and family and with the recognition of divorce in civil law. Historian Carlos Panceras has pointed out that the family during the revolutionary period was the object of remarkable transformations: the abolition of patriarchal rights, the secularization of the civil state and of marriage in 1791, the limitation of the absolute authority of the father of the family, the norms of protection of women and children, the introduction of civil marriage and divorce in 1792, and more generally the application of equal legislation for all citizens in all consequences (473). This study outlines French Revolutionary civil legislation in these areas. Although there was much public debate on the role of women during this period, such as the right to bear arms and to participate in political clubs, this study focuses on the civil legislation which affected women in their daily lives.

Women in Enlightenment Thought

Although, women were not primarily responsible for the sweeping social changes of the French Revolution, nevertheless feminist activity during the period was a catalyst for great change. Championed by women such as Olympe de Gouges, Théroigne de Méricourt, Etta Palm, Claire Lacombe, and many others, the ideals of the Enlightenment were molded to fit the situation of women in Revolutionary France. The era was one of

political unrest in which the movement of ideas inherent in the Enlightenment found practical application to a society.

For women, the central Enlightenment ideal was equality. Jane Abrey's "Feminism in the French Revolution" explains three primary arguments for equality used by feminists in this period: 1) women are human beings with natural rights "explicitly" stated in the Declaration of the Rights of Man, 2) women made immense political contributions to the Revolutionary cause, 3) the biological role of mother gave them "a special claim on the state" due to the fact that they produced citizens for it (52). The arguments for equality went far beyond the biological role of women. Interestingly, the Declaration of the Rights of Man passed by the National Assembly in 1789 made no mention of the rights of women. Worded universally, it could be argued that this document was intended to include women as well as men. The contradiction lay in women's absence from the Declaration of the Rights of Man and their presence in actual legislation, an inconsistency that spurned much protest from Revolutionary feminists. French "public" law and French "civil" law conflicted in their treatment of women. Yet the conflict not only reflected the different treatment of women in public and civil law, but also a conflict with civil law and the egalitarian values of the Revolution (Sledziewski, 411). In one sense women gained rights as participants in Revolutionary activity, yet were excluded from the Revolutionary rights of liberty, equality and fraternity. The mention of women separately in Revolutionary legislation is convincing evidence that they were not intended to be included in the universalism of the Revolution itself. Taking their cue from Rousseau, Revolutionary legislators created separate and unequal rights for women during the French Revolution.

The Enlightenment was a mutation of cultural and intellectual thought, a rejection of obedience to ancient authority. Knowledge was considered valueless unless it served a purpose. Evolving from the work of the Scientific Revolution, the Enlightenment was built on a new confidence in the scientific method, a demystification of the universe through the power of natural laws. This led to the possibility to conceive the state and the Church as two distinct entities giving men the power to write their own laws more freely, separate from their religious beliefs. The most striking accomplishment of the Enlightenment was a notion of human perfectibility attainable through reason and education. John Locke's Essay Concerning Human Understanding, considered the manifesto of the Enlightenment, set forth the theory that the environment played the dominant role in education. With everyone starting with a tabula rasa, infinite improvement was theoretically possible through education. With nature relegated to a subordinate position in the debate of nature versus nurture, women argu-

ably could not be discriminated against on the basis of their "biological role." Alice Browne writes in The Eighteenth-Century Feminist Mind,

After Descartes, the defense of untutored reason was no longer an exercise in mystical paradox. The increased use of vernacular meant that being trained to think no longer depended on a long apprenticeship in Latin which was usually given to boys only. Cartesian independence from the body weakened arguments from physiology against women's rationality (82).

Women's biological role was actually used as fuel for the feminist argument for emancipation. Motherhood became an empowerment, not a hinderance. Many women during this period believed that due to their role as mother, the state owed them a certain homage.

Rousseau's social contract played an equally important role to Cartesian independence from the body in influencing revolutionary change for women. Each individual was bound to the authority of the state assuring their individual liberties and happiness. This contract took place directly between the individual and the state eliminating many institutions and sacraments under the control of the Catholic church, family interference in individual decisions, and the economic constraints and privileges of guilds, the Church, and the aristocracy (Smith,101) . However, there is one aspect of Rousseau's work that cannot be ignored in a study on the view of women. In Émile ou de l'Éducation, Rousseau proposes separate education for boys and girls in which female education is limited to the domestic realm. As a contrast to Émile, Rousseau creates Sophie and then illustrates the curriculum for women proposed in this work. Education was an important rallying point for feminists during this period. Yet in fact Rousseau's popularity went far beyond the social contract, little or arguably no progress was made for women in educational reform during the Revolutionary period.

Despite some arguments advanced for women's emancipation during the period, the Enlightenment was not a feminist movement. The only "philosophe" who expressly argued women's issues was Condorcet (Traer,138). There were, however, many values encouraged by the Enlightenment that were favorable to women in revolutionary France. Secularization, the social contract, equality, tolerance and environmentalism included everyone in theory if not in words. Among others, Voltaire, Montaigne, and Bodin were advocates of divorce legalization believing the indissolubility of the marriage contract to be a violation of man's natural rights (Traer,114). The Enlightenment, like the Scientific Revolution, was a movement away from the intolerance and superstition of the Church. In this way, the Enlightenment charged Revolutionary minds to question the practices and in-

stitutions of the Catholic Church concerning marriage and family (Traer,78).

Marriage

Women related to the Enlightenment ideals of the Revolution in the roles currently prescribed to them, those of mother and wife (Smith ,99). They looked for an improvement of their current situation: equality in marriage, parenthood and family. For example, a group of women in Besançon wrote in their "doléances" to the Estates General in April 1789:

Marriage is a union. People who intend to enter this state should be well suited for each other and not constrained by the will of their parents to marry someone they find repugnant. This happens very often. A young person is made to marry an old person, a young man an old woman or an ugly heiress, without other consideration than their property or their names -as if that sufficed to make a complete union."¹

Olympe de Gouges went as far as to include a sample marriage contract in her Declaration of the Rights of Woman of 1791, a feminist retort to the Declaration of the Rights of Man of 1789. Her sample contract advocated: "mutual inclinations," community property and equal inheritance between children "from whatever bed they come." In this document, acknowledgement of children by their parents gave them the right to bear their parents name and to inherit equally in this document. Further she argues, "We are charged to subscribe to the law which punishes the renunciation of one's own blood," making an even bolder statement against current inheritance laws and the mistreatment of illegitimate children. De Gouges finishes her egalitarian statement about marriage stating, "But how it (my proposal) offers to the wise the moral means of achieving the perfection of a happy government!." De Gouges foreshadowed the Revolutionary legislation of the next five years. ² Revolutionary marriage legislation reflected an attempt by legislators to create the ideal republican family in which women found a place of new respect. Two changes were made that were favorable to women within the institution of marriage: the official secularization of marriage and a reduced age of majority for women.

To eliminate parental control over the choice of spouses and arranged marriages, the age of majority for women and men was lowered. Along with the civil registration of marriage in 1792 "women reached majority at twenty-one" (Abray,58). Previously a woman could not marry without parental consent until the age of twenty-five (Traer,86). Once again eliminating intermediaries, the reduced age of majority encouraged choice of spouses based upon mutual attraction and compatibility and not upon pa-

rental control. The age of majority for men was reduced as well to age twenty-five from the age of thirty (Smith,102; Traer,86). The major flux of revolutionary changes to marriage legislation was to strengthen the bond between the two individuals and the state as well as between the two individuals themselves. Reducing parental control in the choice of spouses reinforced the social contract advocated by the state.

This was not however, the only effect of these revolutionary changes. The state was advocating individual happiness and freedom, even for women, a decision that was reinforced by the introduction of divorce. Reduced parental control over spouses and the new institution of divorce set new standards for marriage in which the happiness of individuals was assured initially and could be remedied if not in fact an acceptable union.

In 1792, marriage was secularized and divorce was made legal. It was not only necessary to place marriage under state control to enable divorce but also to limit the authority of the Catholic church. Such limitation was a direct product of Enlightenment thought. The goal of secularization was, "to remove other mediating elements, such as guilds and families (as well as the Church), that stood between the state and the citizen" (Smith,102). In many ways these various intermediaries were seen as a hinderance to the social contract between the state and the individual. Taking this trend one step further, during this period guilds were abolished and priests were payrolled by the state. As a consequence of secularization, there was a rise in the number of marriages on religious holidays, namely Advent and Lent (Philipp,68). Civil registration of marriage strengthened the state's control over the individual eliminating the influence of the Church and allowing for the institution of divorce.

The secularization of marriage and the introduction of divorce represented a new veneration of democratic family organization. Legislation involving marriage and divorce established an initial equality that was furthered by the abolition of "lettres de cachet," the introduction of family courts and the abolition of complete paternal authority: women gained rights in their households, giving them increased power in parental decision-making.

The Law of August 16, 1790 abolished the "lettres de cachet" and introduced the "tribunal de famille." Legislators envisioned a democratic means of arbitration for families, "replacing the power of the 'père de famille' with that of a council of relatives" (Traer,144). They intended to replace "old school" lawyers sympathetic to the provisions of the "ancien régime" with family members more sympathetic to the situation. This law, abolishing the "lettre de cachet," reduced paternal authority denying him the power to imprison his wife and children.

This elimination of the complete power of the father was continued with the Law of August 28, 1792. This law abolished "la puissance paternelle perpétuelle" (Ortiz, 505). It gave children the power over their own property upon the age of majority. Perhaps more advantageous to children than women, this law once again limited paternal authority.

The different proposals of revolutionary legislator Cambacérès did not mention the responsibilities of a woman toward her husband (or vice versa) as previous legislation had. Nor did they mention the power of a husband to punish an adulterous wife. Revisions in marriage legislation stressed the importance of the marriage contract, a mutual agreement between two individuals based upon love and mutual consent. Furthermore, the indissolubility of marriage was seen as a violation of individual liberty, hence the legalization of divorce. Liberty and equality had found a home in the new democratic family of the state. Assembly member Bar spoke of this new equality at the presentation of the first proposal for the new civil code, "Il a paru juste au comité (le comité chargé de préparer le projet), et conforme au grand et éternel principe de l'égalité, de faire disparaître dans le mariage la ridicule puissance maritale: dans le temps de la liberté, il ne doit subsister aucune espèce de despotisme."³

Divorce

The French Revolution legalized divorce, providing a way for disgruntled spouses to avoid a stricture of the Catholic Church. Up to this point divorce had been illegal in all Catholic countries (Chester, 288). Prior to the Revolution, certain measures could be taken in extreme circumstances, such as adultery. A husband in such circumstance could legally issue a "lettre de cachet" and have his wife either imprisoned, placed in a convent, or even kill her if he actually caught her in an adulterous act (Fulchiron, 378). After such an action had been taken, the husband was also permitted to bring a concubine into the house. The Church also provided for annulments and a form of legal separation. Annulment was possible if the marriage had not been consummated, in the case of impotence, or if it had not been "validly constituted." These "impediments" (to use the terminology of the Church) included: "defects in consent, prohibited degrees of family or spiritual relationship, prior marriage, and previous holy vows taken by one of the parties."⁴ Yet, none of these measures allowed for a legal dissolution of the marriage after it had been consummated. The secularization of marriage made divorce a viable option for men and women during the Revolutionary period. Divorce created a whole new conception of the institution of marriage. It indirectly set standards for what an ideal marriage

was to resemble by outlining unacceptable behavior. Abandonment and ill treatment were prevalent in marriage during the last years of the ancien régime. Women who were able to file for divorce during the Revolution had lived separately from their husbands for a period of two years, in cases of abandonment. Following the Revolution, divorce gave these women a way to actually dissolve a dangerous and humiliating marriage, that had often existed only in theory (Dessertine,78). What Revolutionary marriage legislation had begun, divorce legislation had made final. It provided a new start for women and men, one in which equality was provided by the state, in which a woman could ameliorate her situation legally and without discrimination.

Divorce was legally recognized with the Law of September 20,1792 (Dessertine,77). It could take place if one party wanted it, by mutual consent for irreconcilable differences or under seven specified circumstances (Smith,103). These seven possible grounds for divorce provided by Revolutionary divorce law included: madness or insanity, criminal conviction of one of the two parties, ill treatment or serious injury to one of the parties by the other, abandonment for a period of at least two years or the absence of one of the parties without contact for five years, and emigration in cases planned by the law .⁵ Divorce by mutual consent was free and could take place within a period of two months after filing for it (Dessertine,79). On December 28, 1793 courts were mandated to rule on all divorce proceedings within a month after the initial request making them even faster and more accessible (Maillard,398). Further simplification in the Law of April 23,1794 shortened the period of separation for couples who had not had contact to six months as grounds for divorce. This trend ceased with legislation passed September 17,1797. Due to the continuing increase in divorces during this five year period, the Law of September 1792 specified that divorce could be granted for "incompatibility of temperament" six months after three mandated reconciliation attempts, which were created in the Law of September 1792 (Maillard,578).⁶ In the case of mutual consent or if one party wanted the divorce, proceedings were arbitrated in family councils (Smith,103) .⁷

Although of monumental importance in the struggle for women's rights during the revolutionary period, divorce law was far from equal in its treatment of men and women. Women petitioned for two-thirds of the divorces filed for during the Revolutionary period (Maillard,578). Yet they were not to find equal treatment in the legislation affecting them in divorce proceedings. For example, the Tribunaux de Famille were dominated by men indicating a lingering inequality. Women were not allowed to take part in these councils which operated from 1790 to 1796 (Abrey,59). The contemporary justification for this inequality was the precedent that women were legally

not allowed to serve on juries or as witnesses.

Remarriage also represented a similar inequality. On the one hand, the Law of December 28, 1793 required no waiting period for men after divorce (Maillard, 398). On the other hand, women were required to wait for a ten month period. This waiting period, as well as the stricter legislation of September 1797 can be seen as an attempt by legislators to place limitations on the trend toward women's equality. In 1794, Year II of the Revolution, this law was revised. The revision created two possible circumstances in which a woman could remarry without the ten month waiting period. If the man had been gone for ten months before the divorce had been granted then the waiting period was irrelevant. Also, if a woman gave birth within the ten month waiting period she was allowed to remarry (Phillip, 69).

Another basis for inequality lay in the subject of custody. Daughters were to be given to the mother without exception. However, women were to be given custody of sons only if they were below the age of seven. If the son was older than seven he was to be given to his father (Fulchiron, 383).

For women, the economic situation attained after divorce was generally more optimistic than the outcomes created with custody and representation on family councils. Dominique Dessertine's study of divorce in Lyon during the revolutionary period shows the situation of a divorced woman to be similar to that of a widow. In many cases, women were actually able to recover their dowry at the time of the divorce. If her husband had squandered it, this was less of a hope (79). Most of the women who filed for divorce in Dessertine's study were employed and therefore, some of the most independent women in the city (78). Typically these women were involved in commerce as shopkeepers or seamstresses. Dessertine concludes that this financial security, although not substantial, definitely played a part in women's decisions to file for divorce not only in Lyon, but and presumably in all the urban centers in which divorce was practiced (77).

Hugues Fulchiron's *"La Femme, Mère et Épouse"* studies women within their typical roles in the French Revolution. One section of his study addresses the maintenance of economic dependence for married women during this period. To Fulchiron, this economic discrimination was not founded solely on the basis of sex, but also on the basis of marital status (379). James Traer in *Marriage and Family in Eighteenth-Century France* further elaborates the economic situation of women linking it not only to marriage but also to majority. Law governing majority during the ancien régime perpetuated the belief that women were incapable of governing their own property. Women were kept continually under a "permanent minority" under the "protection" of their fathers, other male relatives and then eventually their husband.⁸ The rhetoric of the Revolution addressed this issue, yet few

actions were taken. In the first two projects of the civil code proposed by Cambacérès, Fulchiron states that the emphasis was on community property over goods and finances. Cambacérès stated, "La loi consacrera la communauté de biens comme le mode le plus conforme à cette union intime, à cette unité d'intérêt, fondement inaltérable du bonheur des familles."⁹ Yet, the law was so oversimplified that it was no more promulgated than the previous law of marital control under the ancien régime. Jane Abrey has asserted that women "could contract debts" and were given "some voice in the administration of their own property".¹⁰ In the third reform of the civil code under the Directory, men regained marital control over property and finances (381). This was a tendency to be rewritten into the law in the Code Napoleon. This recurrent theme in Revolutionary change suggests the popular belief that women were incapable of handling their own finances. Fulchiron quotes another revolutionary legislator who stated, "La loi doit la protéger contre elle-même, comme la loi protège contre eux-mêmes les enfants et les déments" (381). Women found some economic liberty with an employed, unmarried status. If we consider the employed women who filed for divorce, we see that not surprisingly employment allowed for some measure of economic independence during this period. Parental control due to the new majority laws ended at twenty-five. Yet, if not employed or married, in essence a woman was under parental control financially. The "permanent minority" that James Traer talks about was not to end for women during the French Revolution for women. Reaffirmed in the Code Napoléon, it only was given a brief respite during the course of Revolutionary change.

Succession and Inheritance

Under the ancien régime, inequality in inheritance was prevalent. The system of primogeniture, "droit d'aînesse," was protected and even encouraged under the law. By favoring the eldest son in inheritance, the wealth of the family could remain intact further reassuring their maintenance of stature within the nobility.

Historian James Traer divides legislative activity during the Revolutionary period into two phases: the "moderate" from 1789-1792 and the "radical" from 1792-1794. The moderate phase was characterized by an emphasis on individual liberty, the liberty to dispose of one's property freely. The Law of March 15, 1790 abolished the "droit d'aînesse." It also abolished "privileges of masculinity and other rules and customs tending to create unequal distribution of property among formerly noble families" according to gender. This law paralleled the previous Law of August 14, 1789 which formally abolished the nobility (Traer, 159). Not only was this a

triumph for women, but also for middle and lower-class families. No longer would the system of primogeniture dictate status. The Law of March 15, 1790 did not set direct proportions and regulations that dictated the distribution of one's property; it merely stated that privileges and discriminations in inheritance were to be abolished.

This trend in the "moderate" phase of the Revolution was to be continued with the Law of April 8, 1791. Debate in the period between the introduction of these two laws tossed between the moderate and radical views of inheritance law, one advocating individual decision in the determination of one's will and the other mandating "absolute equality." The law ended in a compromise between the two views. It allowed for individuals to make their wills as they pleased provided that in all cases of intestate succession everything would be divided equally among all heirs of the same degree of relationship. In the case of a deceased child, their portion would be divided equally among the remaining heirs.

Controversy thus began over previous legislation. Since inheritance was normally outlined in marriage contract, the legislation of 1790 and 1791 was essentially ineffective. The laws of October 26, 1793 and January 6, 1794 soon remedied this inconsistency in legislation. These two laws added a retroactive element to inheritance legislation. The Law of October 26, 1793 did not allow for children to inherit from their parents until they "restored for purposes of division (rapporteur) any gifts or advantages made to them by their parents before July 14, 1789." Furthermore, any gift given after that date also had to be returned to the parents. One-tenth of an individual's property could be divided freely if the heirs were in a "direct line." In the case of "collateral heirs" only one-sixth of the property could be divided freely. The Law of January 6, 1794 limited inheritance of the inheriting spouse to one-half of the deceased's property, the other half to be equally divided among the children. Limits were also set in monetary terms. The amount of a "gift" was limited to ten-thousand livres provided that the heir did not have this amount already. This law was also retroactive to July 14, 1789. This more radical legislation directly affected women, as spouses and as heirs, and furthermore affected illegitimate heirs and the overall importance of the marriage contract. Inheritance and succession controversies were to become, "the largest single category of litigation in family court" and would eventually lead to its dissolution.¹¹

Inheritance laws in the Revolutionary period mandated equality between male and female heirs. This equality in inheritance between sisters and brothers survived in the Code Napoléon making it a permanent triumph for women (Smith, 103). Due to the retroactive nature of the new legislation, courts during this period overturned previous decisions which

had violated this equality. Revolutionary inheritance legislation allowed for women to gain equality in inheritance retroactively, presently, and in the future under the administration of Napoléon.

Illegitimacy and Paternity

Illegitimate children gained considerable rights during the French Revolution. Under the ancien régime, illegitimate children were allowed to marry, own property and to transmit property, yet, they were not allowed to claim inheritance unless there were no legitimate heirs (Brinton,6). The general rule under the ancien régime was, "the marriage demonstrates the father" (Traer,154). Before the Revolution, unmarried women and widows were required to make a "déclaration de grossesse" declaring their pregnancy and declaring the father. The ancien régime did, however, allow for a rather modern provision called "la recherche de la paternité." This provision allowed for women to bring suit against the father "on behalf of the unmarried mother and child."¹² Torn between humanitarian values in treating all children equally and a new veneration of the legitimate family, revolutionary legislators began to revise laws concerning illegitimacy and paternity (Traer,154).

The Law of September 20,1792 revised the "déclaration de grossesse" replacing it with a declaration of the child's status at birth by a "parent, relative, midwife or surgeon." There were three categories in which a child could be placed: born of two unmarried parents, an adulterine child born of an unwed mother and a married man, or a child of a married woman and another man (Traer,155). Robespierre stated, "The welfare of the state corresponds with the justice and humanity in giving illegitimate children the same help that the law gives others."¹³ Legislation reflecting this enlightened attitude soon followed. The Decree of June 4,1793 followed the revisions of the Law of September 20,1792 declaring that illegitimate children could inherit from both parents. This first decree was the first step towards equality for illegitimate children. The Decree of November 2,1793 furthered the legislation of June giving illegitimate children the right to inherit equally with legitimate children. Adulterine children, as distinguished in the three categories of illegitimate children, could only receive one-third the amount of a legitimate child. Paternity could be proven by correspondence or support if paternity had not been established before death. This change, although a considerable gain, did not provide for equality in status during the lifetime of an illegitimate child's father (Traer,156). This was not the most striking inequality in the legislation of November 1793. Article 340 of this new legislation stated, "La recherche de la paternité est interdite."¹⁴ In

the spirit of the Revolution there was public support for abandoned children.

Yet even this support was discriminatory on the basis of illegitimacy. Legitimate children were accepted into hospice care gratuitously while the mother of an illegitimate child was forced to pay fees (Murat,46). Attitudes during this period demonstrate a strong opposition to unwed mothers.

Article 340 of the Law of November 2,1793 is indicative of this opposition. Debate on "*la recherche de la paternité*" continued until 1804 when the final Civil Code was issued¹⁵. Legislators seemed to believe that "*la recherche de la paternité*" gave promiscuous women some sort of financial gain.

Subsequent legislation in the Decree of May 8,1794 struck once again at the unwed mother, reaffirming the principle that "marriage determines the father." This law reestablished acceptance of the illegitimate child in giving him the father's name, leaving the man responsible for the choice of acceptance or denial. In the case of an unmarried woman, only the mother's name was listed. A husband was allowed in the first instance to take legal action to "disavow paternity" if he wished (Traer,155).

While illegitimate children gained inheritance rights, their mothers were denied compensation for seduction and abandonment. Negative attitudes against unwed or adulterous women were perpetuated with the abolition of "*la recherche de la paternité*". Blame for illegitimacy lay solely on women, namely if she was not married. Children and mothers were expressly forbidden to determine paternity and file for charges, while men could claim or not claim their illegitimate children.

The Code Napoléon

The narrow base on which feminism was supported during the Revolution was denied education and a public forum (Abray, 59). Limitations on public activity of women proved to be detrimental to their cause. The new Civil Code and the subsequent Code Napoléon once again institutionalized the inequalities of the ancien régime neglecting the progress made during the Revolution. Marriage rights returned to parental control. Marriage itself was returned to Church courts, a civil marriage being required before a religious one. Divorce laws renewed the views of the adulteress of pre-Revolutionary France. In the case of adultery, a man would have to have his concubine living in the "common house" to be proven guilty. A woman would merely have to introduce a stranger into the house. If a man actually caught his wife in an adulterous act then murder was justified. The reverse situation would end in imprisonment for a woman. Two

grounds other than adultery were permitted for grounds for divorce, conviction and "grave insults or cruelty." Legal separation was only allowed if the couple had been married in between two and twenty years. Men regained power over marital property, a wife needing "special authorization for each civil act." Illegitimate children under the Code Napoléon could receive no inheritance, Napoleon proclaiming, "Society has no interest in having these bastards recognized" (Holtman,91). Unmarried women were not allowed to be guardians or to witness legal documents. "Lettres de cachet" were reinstated (although not in name) allowing for men to imprison their wives for up to two years and his children from six months to a year depending on their age (Holtman,91). As these transformations show, Revolutionary progress for women was completely destroyed.

Conclusion

The French Revolution marked a brief period of liberalism in eighteenth-century France. Enlightenment ideals were applied to all levels of society through political upheaval. Revolutionary legislators separated their religious beliefs from the legal system and created a more liberal codification of the law.

Women found a new equality in their households as wife , daughter and mother. Emancipated from parental authority at a younger age of majority, women found a new freedom in the selection of a spouse not found in the arranged marriage of the ancien régime. In marriage itself, women gained a voice in parental decision-making and were freed from the marital authority of their husbands. Divorce gave women the right to end their marriages, legally and almost without discrimination. The abolition of the "lettre de cachet" and the establishment of the family court showed a new veneration and respect of mother and children in the Revolutionary period. Inheritance laws allowed for illegitimate children to inherit equally with legitimate children. The system of primogeniture was also legally abolished giving male and female heirs equal inheritance rights.

But even during the revolutionary era inequalities remained. Revolutionary legislation had created a "double paradox" as explained by Hugues Fulchiron: women given a new equality in their households as mothers remained inferior as spouses. Secondly, liberated from their family and husband, women remained economically dependent on their husbands (383). Fulchiron continues, asking a very important question. Was society during the Revolutionary period ready for a complete overhaul of existing principles? In the situation of women, no. Accepting completely the egalitarian standards of the Enlightenment would have meant giving totally equal rights

to all layers of society, including women. The vestiges of the ancien régime could not have been completely destroyed in five years of legislation; social change does not generally happen that rapidly.

The Revolution did not provide complete equality for women. Yet, the gains made for women during this period are even more striking when compared to the Code Napoléon which eventually succeeded them. Women made several important, short-lived steps towards equality in the French Revolution that were overshadowed by the Code Napoléon for over one-hundred years.

Notes

¹ Doléances des Femmes de Franche-Comté (Besançon, April 27,1789),25, qtd.in Traer,83.

² de Gouges,Olympe. Les Droits de la Femme (Paris,n.d.,1791) qtd. in Harriett Branson Applewhite,94-95.

³ Motifs des Dispositions du titre III du livre I du Code Civil sur les droits des époux, présentés, au nom du comité de législation, par le citoyen Bar, député de la Moselle. Arch.Parl.,t.70,p.636. qtd. in Fulchiron,378.

⁴ Ourliac, Paul and J. de Malafosse. Le droit Familial. .Paris: Presses Universitaires de France, 1968.pp.126-159. qtd. in Traer, 29.

⁵ " Sept motifs déterminés ont été reconnu: 10) la démence,la folie ou la fureur de l'un des deux époux, 2)la condamnation de l'un d'eux à des peines afflictives ou infamantes,3) les crimes, sévices ou injures graves de l'un envers l'autre, 4) le dérèglement de moeurs notoire,5) l'abandon de la femme par le mari ou du mari par la femme pendant deux ans du moins, 6) l'absence de l'un d'eux sans nouvelles au moins pendant cinq ans, 7)l'émigration dans les cas prévus par les lois." (Dessertine,79)

⁶ Informal separation was not recognized as a ground for divorce in France until January 1st 1976. It may be that the average total period between the end of cohabitation and the pronouncement of the decree presently is perhaps somewhat between 18 and 24 months (Chester,162).

⁷ The family council (tribunal de famille) was proposed as a substitute for the "lettre de cachet". "The law as finally passed provided that in cases of dispute between husband and wife, father and son, grandfather and grandson, brothers and sisters, nephews and uncles, or other persons within the same degrees of relationship, the parties were required to name relatives as arbiters" (Traer,144).

⁸ Ourliac, Paul and J. de Malafosse. Le Droit Familial. Paris: Presses Universitaires de France,1968. pp.126-159. qtd. in Traer,139.

⁹ " Rapport Fait à la Convention Nationale au nom du comité de législation sur le premier projet de Code Civil," Fenet qtd. in Fulchiron,379.

¹⁰ Without access to the statutes, it is impossible at this juncture to come to definitive conclusions as to the extent to which women gained control over their property. However, the Napoleonic Code returned control over finances and property to men. Women were to have "special authorization for each civil act" (Holtman,90).

¹¹ The discussion of succession and inheritance comes largely from Traer pp.159-161.

¹² Pouzol,A. La Recherche de la Paternité. Paris,1972. qtd. in Brinton,8.

¹³ Robespierre, Maximilien. Les Droits de l'état des bâtards. Arras: Académie des Sciences, Lettres et Arts,1971.p.74. qtd. in Smith,103.

¹⁴ Fenet. Recueil Complet, X, 47 ff. qtd. in Brinton,48.

¹⁵ " The subject is not mentioned in the clauses of the état civil in the completed code, but silence was interpreted rightly enough as unfavorable to the mother" (Brinton,49).

Tory Simpson is a Senior French major from Huntsville, Alabama. This article was a Junior Interim project contracted with Dr. V. Markham Lester and Dr. Dominique Linchet. Next year, Tory will be pursuing her Master's in French at the University of Alabama as a graduate teaching assistant.

WEILY SOONG, SUSAN J. DUBAY, BRIAN A. BRODY,
AND ERIC HUNTER

*Functional Analysis of the Leucine Zipper Motif in the
Mason-Pfizer Monkey Virus Transmembrane Glycoprotein*

MANY RETROVIRUSES, INCLUDING the Mason-Pfizer monkey virus (M-PMV), contain a leucine zipper-like repeat in a highly conserved region of the external domain of the transmembrane (TM) glycoprotein. The region has been postulated to play a role in virus-cell fusion and viral infection. To determine what role this region might play in M-PMV envelope structure and function, several expression vectors with mutations engineered into the leucine zipper motif of M-PMV were made. Dideoxy sequencing confirmed the creation of vector constructs that have the leucine zipper mutations within a plasmid containing the entire infectious M-PMV proviral genome. These constructs were used to study the effects of the leucine zipper mutations on protein synthesis and processing and on viral infectivity and replication. Sequencing also confirmed the creation of vector constructs that have the leucine zipper mutations in the plasmid pTMO-TL15. pTMO-TL15 expresses a truncated cytoplasmic domain of the TM glycoprotein and has been shown to cause a high potential for cell-to-cell fusion. These constructs were used in the fusogenic potential analysis to study the effects of the mutated viral envelope glycoproteins on fusion. The infectivity and replication analyses further suggest that the leucine zipper motif may play a role in viral infectivity and replication. However, these results are only preliminary. No conclusions can yet be made on the role of the leucine zipper motif in M-PMV from these experiments, and further testing must be done.

INTRODUCTION

Members of the retrovirus family are spherical, RNA-containing viruses that are enveloped by a membrane acquired during budding from the plasma membrane of an infected cell. They have common morphological features that reflect similar mechanisms of morphogenesis. Retroviruses have a genome of RNA and have the reverse transcriptase enzyme (RT). Covering and protecting the RNA and RT is a protein capsid which is surrounded by a membrane envelope—containing glycoproteins—that is derived from the cell. Two distinct life-cycle pathways appear to operate for the intracellular transport of the viral capsid proteins, which result in two different morphogenic processes for different retrovirus types. In C-type retroviruses, such as the human immunodeficiency virus (HIV) and the Rous sarcoma virus (RSV), the capsid is assembled, from individually transported capsid precursor proteins, as the virus buds from the plasma membrane. B-type and D-type retroviruses have an immature capsid that is pre-assembled within the cytoplasm prior to transport to the cell membrane (Rhee and Hunter, 1990). However, the morphology of the mature D-type retrovirus more closely resembles that of C-type viruses, in that in general, the protein capsid is cylindrical and centrally located (Hunter *et al.*, 1985).

The Mason-Pfizer monkey virus (M-PMV) is the prototype D-type retrovirus that was isolated from a mammary tumor of a female rhesus monkey. The structure of the M-PMV is similar to other retroviruses (Figure 1). These structural components of M-PMV play an important part in its life cycle. During the early phase of the M-PMV life cycle, the viral glycoproteins on the viral envelope bind to receptors on a mammalian cell, allowing the retroviral envelope to fuse with the cell membrane (Figure 2). When the retroviral capsid enters the cell, the RT of M-PMV is activated. The RT, an unusual DNA polymerase, produces a single-strand DNA copy of the RNA, called cDNA, forming a hybrid helix of RNA and cDNA. The RT is used again to synthesize a matching strand of cDNA to produce a double-stranded cDNA. This double-stranded cDNA is incorporated into the infected cell's genome so that the cell's genome now contains a DNA copy of the M-PMV RNA genome. Therefore, the regular genetic and protein synthesis mechanisms of the infected cell are used to create the materials to produce more viruses. As viral mRNA molecules are transcribed from this viral DNA, these mRNAs are translated into the M-PMV's structural components—the capsid proteins, the glycoproteins, and RT.

During the late phase of the M-PMV life cycle, the mRNA, RT, and capsid proteins combine within the cytoplasm and form the protein capsid. Meanwhile, the viral glycoproteins move to the plasma membrane of the

cell. The protein capsid moves from the cytoplasm to the cell membrane and buds out of the cell by extruding the cell membrane envelope and its associated viral glycoproteins (Rhee and Hunter, 1990).

The RNA genome of the M-PMV encodes the genetic information needed for the synthesis of M-PMV's structural components. The RNA genome is composed of four gene regions—*gag*, *pro*, *pol*, and *env* (Figure 3). Each gene region encodes proteins making up a specific structure or functional unit. The four gene regions of M-PMV synthesize four protein precursors. The *gag* region is translated to Precursor 78 (Pr 78) with a molecular weight of 78 kilodaltons. During protein synthesis, approximately 15% of the time, a codon shift occurs before the stop codon at the end of the *gag* gene, and synthesis continues into the *pro* region. The translation of the *gag-pro* regions results in Pr 95. Another codon shift occurs with similar frequency at the end of the *pro* region, and the *pol* region is translated to yield Pr 180 from the *gag-pro-pol* region. The fourth precursor, Pr 86-*env*, comes from the *env* region (Hunter, et al., 1985).

These four precursors are processed and cleaved into individual proteins. Pr 78 of the *gag* region is processed into proteins p10, p16, p27, p12, p14 and p4. These six proteins are known to make up the protein capsid of the M-PMV. Pr 95 contains these proteins plus a protein that carries out precursor protein cleavage. Pr 180 contains not only the precursors Pr 78 and Pr 95 but also the protein for the RT enzyme (Hunter, et al., 1985).

The protein precursor, Pr 86-*env*, is cleaved by a cellular endopeptidase in a late Golgi compartment, producing two mature viral glycoproteins (Figure 4). The surface (SU) glycoprotein, gp 70, mediates binding of the M-PMV to a specific, but not yet characterized, cell surface receptor. The transmembrane (TM) glycoprotein, gp22, has three regions. The extracellular domain of the TM glycoprotein provides an area for association with the SU glycoprotein, consisting of noncovalent interactions that hold the two glycoproteins together. The complex of these two proteins is tethered within the plasma membrane by the presence of the TM glycoprotein's 28-amino acid membrane-spanning domain. The 38-amino-acid cytoplasmic domain of the TM glycoprotein is immediately inside the infected cell membrane (Brody *et al.*, 1994). Besides anchoring the SU glycoprotein to the surface of the virion, the TM protein seems to provide the fusion function of the virus to a host cell (Dubay *et al.*, 1992).

After release of the immature virus, a viral protease-mediated cleavage occurs within the cytoplasmic domain of the TM glycoprotein, resulting in the loss of approximately 16 amino acids from the carboxy terminus. This converts the gp22 glycoprotein incorporated at the cellular membrane into a gp20 glycoprotein found within the virion. Although the functional re-

quirement for this cleavage is not fully understood, the cytoplasmic domain of the TM glycoprotein seems to interact specifically with the capsid proteins during viral budding, causing cleavage and the maturation of the virus. The fusion activity of the virus with its host cell seems to be dependent on this cleavage (Brody *et al.*, 1994).

Another characteristic of the TM glycoprotein is the leucine zipper motif located within the extracellular domain of the glycoprotein. The leucine zipper motif was originally described for several DNA-binding proteins. It is characterized by a heptad of amino acids consisting of a leucine (or isoleucine) residue followed by six other amino acids, and this heptad is repeated several times. This leucine zipper motif has an α -helix protein structure; thus, hydrophobic amino acids are found at the first and fourth residues of the heptads throughout the region, giving the characteristic coiled-coil structure (Dubay *et al.*, 1992).

This leucine zipper motif has been identified in the membrane-spanning transmembrane protein of paramyxovirus and in the TM glycoprotein of many retroviruses. This heptad repeat of leucine and isoleucine residues is thought to be important since this region was found to be highly conserved throughout diverse isolates of HIV-1 as well as simian immunodeficiency virus (SIV) and HIV-2 (Dubay *et al.*, 1992).

The leucine zipper motif had been postulated to play a role in stabilizing the oligomeric forms of viral TM molecules. Many retroviral membrane-spanning proteins are known to be arranged on the surface of the cell in oligomeric structures consisting of homomultimers of the protein. The oligomerization of viral glycoproteins appears to be necessary for the proper transport of the glycoprotein through the cell's secretory pathway and presumably maintains the protein complex in a transport-competent conformation (Dubay *et al.*, 1992). The leucine zipper region of the TM protein was thought to interact with adjacent protein subunits to stabilize the oligomeric structure of the glycoprotein complex in a manner similar to the stabilization of DNA-binding proteins. In HIV-1, mutations in the leucine zipper motif were found not to interfere with protein transport or oligomerization but completely stopped envelope-mediated cell fusion of the virus to the host cell and virus infectivity (Dubay *et al.*, 1992). Thus, it is suspected that the leucine zipper motif may play some role in cell-viral fusion and in viral infectivity and replication.

To further analyze the function of the leucine zipper motif, we used mutations that were done in the leucine zipper region of the M-PMV genome and studied their effects on viral protein synthesis, replication, infectivity, and fusion. Since this D-type retrovirus completes capsid assembly before budding, the M-PMV provides a powerful system in which to exam-

ine the interactions of the TM glycoprotein with a complete, budding capsid and the eventual viral fusion and infectivity with a host cell (Brody *et al.*, 1994). Recombinant DNA technology was used to clone a portion of the M-PMV *env* gene, containing point mutations in the leucine zipper region into a infectious molecular clone of the DNA version of the entire M-PMV genome. These new vector constructs were needed to study the effects of these point mutations on viral protein synthesis and on viral infectivity and replication over an extended period of time. Recombinant DNA technology was used also to clone the portion of the M-PMV *env* gene containing these leucine zipper mutations, into another vector called pTMO-TL15. These new constructs were needed to measure the fusogenic potential of these mutants.

MATERIALS AND METHODS

Cell culture and transfections:

COS-1, HeLa, and Hos cells were obtained from the American Type Culture Collection. COS-1 cells are African monkey cells. HeLa cells are oncogenic human cells, and Hos cells are human osteosarcoma cells. HeLa cells were maintained in Dulbecco's modified Eagle's medium supplemented with 5% fetal bovine serum. COS-1 and Hos cells were grown in Dulbecco's modified Eagle's medium plus 10% fetal bovine serum. All COS-1 transfections were performed by using DEAE-dextran.

Plasmids:

The expression vector pSHRM15 (13.8 kilobasepairs) contains the entire DNA copy of the M-PMV genome, which includes the *gag*, *pro*, *pol*, and *env* genes, under the control of the simian virus 40 (SV40) late promoter and the M-PMV long terminal repeat, providing the polyadenylation signals (Figure 5). pSHRM15 also contains a gene for ampicillin resistance.

pTMO is a 8.5-kilobasepair expression vector that contains the M-PMV *env* gene under the control of the SV40 late promoter (Figure 6). The pTMO vector was used as the cloning vector to make all of the mutation within the leucine zipper region of the M-PMV. The mutants used for this experiment were made by and were obtained from Brian Brody (Figure 7). pTMO has also a gene for ampicillin resistance.

pTMO-TL15 is the pTMO expression vector with a deletion near the end of the *env* gene. Like pTMO, pTMO-TL15 encodes for the SU and TM glycoproteins, but pTMO-TL15 also has a 13 amino acid deletion at the end (or the tail) of the cytoplasmic domain of the TM glycoprotein. This mutation, designated as TL15, leaves only 15 amino acids at the tail end of the

TM glycoprotein (Figure 4). Because of this deletion, pTMO-TL15 seems to encode for retroviral glycoproteins with enhanced cell-to-cell fusogenic potential (Brody *et al.*, 1994).

Construction of vectors for viral protein synthesis analysis and for viral replication and infectivity analysis (Figure 8):

pTMO vectors containing the various leucine zipper mutations were digested at the same time with *NheI* and *Bpu1102* restriction enzymes. *NheI* was purchased from New England Biolabs (Beverly, Mass.), and *Bpu1102* was purchased from GibcoBRL. GibcoBRL 10x reaction buffer #2 was used for the digestions; the rest of the digestion procedures were performed according to GibcoBRL's instructions or standard technique (Maniatis *et al.*, 1982). pSHRM15 was partially digested with the restriction enzyme *Bpu1102* for 5 minutes at 37°C. The reaction condition for this partial digestion was done according to GibcoBRL's instructions. This partial digestion was extracted from the digestion salts by phenol/chloroform extraction (Maniatis *et al.*, 1982) and then digested with *NheI*, according to manufacture's instructions. This pSHRM15 double digestion was dephosphorylated using the Arctic Shrimp Alkaline Phosphatase system (United States Biochemical Corp., Cleveland Ohio).

The *NheI* and *Bpu1102* digestions of pTMO with the leucine zipper mutations and of pSHRM15 were seen on 1%-agarose gel electrophoresis. The pTMO digestions yielded two DNA fragments; the smaller fragment (~0.5 kb)—containing the mutations in the leucine zipper region—was cut out of the agarose gel and was extracted by the gel-squash method (Maniatis *et al.*, 1982). The pSHRM15 partial digestion yielded five fragments; the largest fragment (~13.3 kb), containing the entire M-PMV infectious clone minus the region with the leucine zipper motif, was cut out of the agarose gel and was extracted by the gel-squash method (Maniatis *et al.*, 1982). The ~0.5 kb fragment from each of the pTMO leucine zipper mutants and the ~13.3 kb fragment from pSHRM15 were ligated together in the presence of T4 ligase and 10x T4 ligase buffer to form new vector constructs, containing the leucine zipper mutations in the pSHRM15 infectious clones.

The ligation mixture was then transformed into competent *E. coli* DH-1 (Maniatis *et al.*, 1982) and plated on LB+ampicillin plates. Colonies were produced and were screened to determine which colonies contained the new vector constructs. Several colonies of each leucine zipper mutant were grown in 3 mL of LB+ampicillin medium, and mini-preparations of the DNA were done by alkaline lysis (Maniatis *et al.*, 1982). All of the mutants were confirmed by *NheI* and *Bpu1102* restriction enzyme digestions and by

dideoxy sequencing using the Sequenase system (United States Biochemical Corp., Cleveland, Ohio). Vector constructs with the confirmed mutations were propagated in *E. coli* DH-1 cells and purified by using cesium chloride gradients as described previously (Maniatis *et al.*, 1982), using a Beckman TL100 ultracentrifuge (Beckman Instruments).

Viral protein synthesis analysis (Pulse/Chase Assay): 60-mm-diameter plates of COS-1 cells were transfected with the pSHRM15 expression vectors containing the leucine zipper mutants. Two days after transfection, the cells were starved with leucine-free medium (GIBCO) for 1 hour. After removal of this medium, the cells were pulse-labeled for 30 minutes with leucine-free medium containing [³H]leucine at 400 μ Ci per 60-mm-diameter plate. At the end of the pulse period, the radioactive medium was removed. One set of cells was lysed immediately by the addition of 1 mL of lysis buffer A (1% Triton X100; 25mM Tris-HCl, pH 8.0; 50 mM NaCl; 1% Na Deoxycholate; water), and viral proteins were immunoprecipitated by the addition of goat antiserum prepared against whole disrupted M-PMV. Complete medium was added to the other sets of cells, and the cells were chased for 3 hours. Chase lysates were prepared, and viral proteins were immunoprecipitated in the same manner as the pulse lysates. Immunoprecipitated proteins were separated by sodium dodecyl sulfate-polyacrylamide gel electrophoresis (SDS-PAGE) (12% polyacrylamide) and examined by fluorography after impregnation of the gel with EnHance (NEN).

Viral replication and infectivity analysis (Reverse Transcriptase Assay): 60-mm-diameter plates of COS-1 cells were transfected with the pSHRM15 expression vectors containing the leucine zipper mutants. Two days after transfection, the cell supernatants were collected, and part of the supernatants were assayed for reverse transcriptase activity as described below. Based on this initial assay, supernatants containing whole virions were adjusted to equivalent amounts of virions based on the reverse transcriptase activity values, using Dulbecco's modified Eagle's medium. Appropriate amounts of the supernatants were used to infect 50% confluent monolayers of HeLa cells in the presence of 2 μ g of Polybrene (hexadimethrine bromide; Sigma, St. Louis, Mo.) per mL. The cells were incubated for 1 hour at 37°C before fresh culture medium was added.

Supernatants were collected 3, 6, 10, 13, and 17 days later and were assayed for reverse transcriptase activity to determine viral replication and infectivity. In the RT assay, the virus in the supernatants were pelleted, and each pellet was lysed with 12 μ L virion lysis buffer (50mM Tris, pH 7.8; 100mM KCl; 0.05% Triton X-100; 2mM DTT). To radioactively label the

reverse transcriptase, 7.5 μ L of each of the lysed virions were reacted with 32 μ L of a radioactive reaction cocktail (50 mM Tris, pH 7.8; 100 mM KCl; 2 mM DTT; 7.5 mM MgCl_2 ; 8 μ Ci of ^{35}S]TTP; 1.25 μ g poly A \cdot dT). The reaction mixtures were incubated for 1 hour at 37°C, and each reaction was terminated by the addition of 12.5 μ L of 200 mM sodium pyrophosphate. All the reactions were blotted onto NA45 nitrocellulose paper, using a dot blot apparatus, and air dried. The blot was washed with 0.5 M sodium phosphate buffer (pH 6.8) and quantitated by using an AMBIS radioanalytical imaging system (AMBIS Systems, Inc., San Diego, Calif.).

Construction of vectors for viral fusion analysis (Figure 9):

The pTMO vector containing the various leucine zipper mutants and the pTMO-TL15 vector were digested in reactions with both MroI and Bpu1102 restriction enzymes. MroI was purchased from BM (Borhinger), and Bpu1102 was purchased from GibcoBRL. GibcoBRL 10x reaction buffer #2 was used for the digestions; the rest of the digestion procedures were performed according to GibcoBRL's instructions or standard technique (Maniatis *et al.*, 1982). The digestions of the pTMO-leucine zipper mutants were dephosphorylated using the Arctic Shrimp Alkaline Phosphatase system (United States Biochemical Corp., Cleveland Ohio).

The MroI and Bpu1102 digestions of pTMO with the leucine zipper mutations and of pTMO-TL15 were seen on 1%-agarose gel electrophoresis. pTMO-TL15 digestion yielded two DNA fragments; the smaller fragment (~0.5 kb)—containing the TL15 tail mutations in the *env* gene—was cut out of the agarose gel and was extracted by the gel-squash method (Maniatis *et al.*, 1982). Digestions of pTMO with the leucine zipper mutations also yielded two fragments; the largest fragment (~8.0 kb), containing the mutations in the leucine zipper motif, was cut out of the agarose gel and was extracted by the gel-squash method (Maniatis *et al.*, 1982). The ~8.0 kb fragment from each of the pTMO-leucine-zipper-mutants and the ~0.5 kb fragment from pTMO-TL15 were ligated together in the presence of T4 ligase and 10x T4 ligase buffer to form new pTMO vector constructs, containing the leucine zipper mutations and the TL15 tail mutation.

The ligation mixture was then transformed into competent *E. coli* DH-1 (Maniatis *et al.*, 1982) and plated on LB+ampicillin plates. Colonies were produced and were screened to determine which colonies contained the new vector constructs. Several colonies of each leucine zipper mutant were grown in 3 mL of LB+ampicillin medium, and mini-preparations of the DNA were done by alkaline lysis (Maniatis *et al.*, 1982). All of the mutants were confirmed by MroI and Bpu1102 restriction enzyme digestions and by

dideoxy sequencing using the Sequenase system (United States Biochemical Corp., Cleveland, Ohio). Vector constructs with the confirmed mutations were propagated in *E. coli* DH-1 cells and purified by using cesium chloride gradients as described previously (Maniatis *et al.*, 1982), using a Beckman TL100 ultracentrifuge (Beckman Instruments).

Analysis of fusogenic potential (Cell-to-cell Fusion Assay):

60-mm-diameter plates of COS-1 cells were transfected with the new pTMO constructs, containing the TL15 mutation and the leucine zipper mutations. Two days after transfection, the cells were harvested and were mixed with Hos cells, at a 1/20 effector cell (transfected COS-1 cells) to target cell (Hos cells) ratio, and grown in the appropriate medium. After 20 hours of growth, cell monolayers were treated with May-Grundwald stain followed by Giemsa staining and syncytia were observed under light microscopy. Well-separated syncytia were used to count the number of nuclei contained within each.

RESULTS

Confirmation of M-PMV Leucine Zipper Mutations:

Leucine zipper mutations in the expression vector pTMO were obtained. Figure 7 shows the leucine zipper motif and the intended mutations within this region. The mutations were designated as LZ2C (I45V), LZ2C/1G (I45V / L52V), G12 (Glu 12: I45E), LZ404 (I45E / L52E), LZ402, LZ401 (I45E / S47R / L52E), and MK201. After cloning these leucine zipper mutations in pSHRM15 and in pTMO-TL15, the new constructs were confirmed by restriction enzyme digestion and by sequencing. Sequence analysis showed that three mutants—originally designated as LZ2C (I45V), LZ404 (I45V / L52E), and LZ402—did not have the mutations that were intended. LZ2C had a leucine to valine mutation at amino acid residue 52 instead of residue 45. LZ404 was the same mutation as LZ2C—a leucine to valine mutation at amino acid residue 52 instead of a double mutation of two glutamates. LZ402 did not have the four amino acid deletion; LZ402 had the same mutation as LZ2C. Therefore, LZ2C, LZ404, and LZ402 had the same L52V mutation. Figure 10 shows the confirmed mutations in the M-PMV leucine zipper region.

Attention was focused on eight of these new constructs. Five constructs had the leucine zipper mutants in pSHRM15. pSHRM15-LZ2C, pSHRM15-LZ2C/1G, pSHRM15-G12, pSHRM15-LZ401, and pSHRM15-MK201 were used to do protein synthesis analysis and viral infectivity and replication analyses (Figure 8). The three other constructs had the leucine

zipper mutants in pTMO-TL15. pTMO-TL15-LZ2C, pTMO-TL15-LZ2C/1G, and pTMO-TL15-G12 were used to do analysis of their fusogenic potential with COS-1 and Hos cells (Figure 9).

Protein Synthesis Analysis:

Protein synthesis analysis for pSHRM15-LZ2C, pSHRM15-LZ2C/1G, pSHRM15-G12, pSHRM15-LZ401, and pSHRM15-MK201 was not done because the results of the pulse/chase experiment could not be determined (Results of pulse/chase not shown). Each immunoprecipitated sample had a high radioactive background and contained non-M-PMV proteins. The combination of these two factors made the M-PMV proteins indistinct on the polyacrylamide gel, thus making identification of the M-PMV proteins impossible. Time constraints prevented another pulse/chase experiment using the same expression vectors to be done.

Viral Infectivity and Replication Analysis:

Analysis of the infectivity and replication of the viral mutants was determined by assaying for the production of reverse transcriptase. The results of reverse transcriptase production for pSHRM15, pSHRM15-LZ2C, pSHRM15-LZ2C/1G, pSHRM15-G12, pSHRM15-LZ401, and pSHRM15-MK201 were inconclusive (Figure 11). As expected, wild-type M-PMV (pSHRM15) began to produce a relatively high amount of reverse transcriptase around the sixth day after infection, with its peak production around day 10. The leucine zipper mutants, for the most part, did not produce any significant amounts of reverse transcriptase. Time constraints prevent another 17-day RT assay to be performed to verify this initial RT assay. Because of this, these RT results can only be considered preliminary.

Analysis of Fusogenic Potential (Cell-to cell Fusion Assay):

Analysis of the fusogenic potential of the viral construction pTMO-TL15-LZ2C, pTMO-TL15-LZ2C/1G, and pTMO-TL15-G12 was determined by a fusion assay. The wild-type pSHRM15, the pTMO-TL15 vector, and the mutants did cause fusion of the infected COS-1 cells with the a number of Hos cells to create multinucleated syncytia. However, the mean number of nuclei per syncytium was around six which was statistically too small to draw any conclusions (Results not shown). Due to time constants, another fusion assay using 35-mm-diameter plates could not be done.

DISCUSSION

Very few preliminary conclusions about the leucine zipper motif of the M-PMV can be reached by the results of the viral protein synthesis analysis, the viral infectivity and replication analysis, and the fusogenic potential analysis. In order to do these analyses, two sets of viral constructs were created. One set of constructs contained the M-PMV leucine zipper mutations in the M-PMV infectious clone of pSHRM15. These clones produced live and complete virions with mutations in the leucine zipper region and were used to determine viral protein synthesis and viral infectivity and replication. The second set of constructs contained the M-PMV leucine zipper mutations in the expression vector pTMO-TL15. pTMO-TL15 has been found to produce M-PMV envelope glycoproteins causing enhanced cell-to-cell fusogenic potential; therefore, it is a good vector to study the fusogenic potential of the leucine zipper mutants.

Viral protein synthesis analysis was done to determine any modifications of the protein products encoded by the leucine zipper mutants. The 30-minute pulses with leucine-free medium containing [^3H]leucine are supposed to radioactively label the proteins synthesized by the cells during that time. The four-hour chases in complete medium is used to follow the processing and maturation of these newly synthesized proteins. The pulse and the chase cells are lysed, and the M-PMV proteins are separated from the rest of the cellular proteins by immunoprecipitation with anti-M-PMV goat antibodies. The M-PMV proteins are then separated by SDS-PAGE. However, nothing could be determined from the results of the pulse/chase experiment because the experiment yielded indistinct M-PMV protein bands and a high radioactive background. This result indicates the addition of too much radioactivity during the pulse labeling, an ineffective immunoprecipitation, and the need for better handling of the cells during transfection, pulse labeling, and chasing.

The reverse transcriptase assay was performed to determine the effects of the leucine zipper mutations on viral infection and replication. pSHRM15 constructs with the leucine zipper mutations were transfected into COS-1 cells. These cells transcribed and translated the viral DNA constructs, producing live virions which bud out of the cells and into the media supernatants. The amount of virions in these supernatants is measured by the amount of retroviral RT in the supernatants. Equal amounts of virions in the supernatants were used to infect HeLa cells. If the viruses are able to infect cells, they are able to enter the cells and replicate. Viral replication produces more retroviral proteins, including reverse transcriptase, and releases whole viruses in the supernatants. Therefore, RT amounts are a good

indicator of viral infectivity and replication. After infection, the cell supernatants were collected for 17 days, and whole virions were separated from the supernatants and lysed. The viral RT was radioactively labeled and quantitated.

The results of the RT assay might give a small indication that the mutations in the leucine zipper motif may play a role in preventing virions from infecting and replicating in HeLa cells. For the wild-type M-PMV, the infection and replication rates seem to be slower than normal despite a high production of RT because the peak RT production is normally around the seventh day after infection. Additionally, all of the mutants produced low amounts of RT; therefore, these mutants may be non-infectious and, thus, unable to replicate themselves. However, there was a noticeable trend of increasing RT production in pSHRM15-401 ten days after infection and in pSHRM15-2C/1G and pSHRM15-G12 thirteen days after infection. This slight trend may indicate that these constructs are infecting the cells but producing a very low titer of virus at a very slow rate. However, the RT assay must be repeated to confirm these suspicions.

The fusion assay was done to determine the effects of the leucine zipper mutations on viral envelope glycoprotein-to-cell receptor fusion. Since all the pTMO-based constructs contained only the M-PMV *env* gene, the SU and TM glycoproteins were the only viral proteins produced by COS-1 cells when the constructs were transfected into the COS-1 cells. Using the cell's machinery, the envelope glycoproteins are transported to the cell surface and cover the surface of the cell membrane. The viral glycoproteins on the COS-1 cells then bind to their receptors on the Hos cells and cause the cell fusion of COS-1 and Hos cells. In cell fusion, the cell membranes of the fused cells come together, creating multinucleated cells called syncytia. Viral glycoprotein-producing constructs causing higher numbers of nuclei per syncytium have greater fusogenic potentials. Wild-type M-PMV produces only four to five nuclei per syncytium, making it difficult to quantitate fusogenic potential. Meanwhile, pTMO-TL15 with the TM glycoprotein cytoplasmic domain truncated was found to produce 50 nuclei per syncytium. Thus, the TL15 mutation was added to leucine zipper mutants to make fusogenic potentials easier to quantitate and to distinguish mutant fusogenic results from wild-type fusogenic results (Brody *et al.*, 1994).

The preliminary results of the fusion assay yielded syncytium with an average of six nuclei for the wild-type pTMO, the pTMO-TL15 vector, and all of the leucine zipper mutant constructs in pTMO-TL15. The addition of the pTMO-TL15 mutation to the leucine zipper mutation was supposed to cause around fifty nuclei per syncytium. Thus, only the presence of a large number of nuclei per syncytium can be considered an enhance-

ment in fusogenic potential of the mutants. Therefore, the effects of the leucine zipper mutations could not be determined. The use of 60-mm-diameter plates rather 35-mm-diameter plates for this fusion assay was the probable cause for the low number of nuclei per syncytium. The large diameter plates spread the cells too thinly, preventing the cells from making contact with each other and fusing together. The fusion assay must be repeated.

Based on the initial preliminary results of the reverse transcriptase assay, the leucine zipper motif in M-PMV may play a possible role in viral replication and infectivity. Also, since the leucine zipper mutants in the fusion assay did yield some multinucleated syncytia, the leucine zipper may possibly have a function in virus-to-cell fusion, but to what degree is its role in this fusion process is still unknown. The fusion assay may also suggest that the SU and TM glycoproteins are being produced and properly transported to the cell surface, possibly indicating that the leucine zipper motif does not affect envelope glycoprotein oligomerization and its cytoplasmic transportation. Studies on the function of leucine zipper motifs in HIV-1 indicate that the region does not play a major role in HIV-1 envelope oligomerization, that the functional role of this domain is related to the series of events associated with viral entry (viral mediated cell-cell fusion and infection), and that the coiled-coil structure located within this region is a critical component of this process (Wild *et al.*, to be published). The function of the leucine zipper motif in M-PMV is still undetermined. No conclusions can be made on the role of the leucine zipper motif in M-PMV from these experiments because further studies need to be done to repeat and verify these preliminary data.

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FIGURE LEGENDS

FIGURE 1: A schematic drawing of the structure of the Mason-Pfizer monkey virion (M-PMV). The cylindrical M-PMV protein capsid contains an RNA genome and the reverse transcriptase enzyme. The protein capsid is surrounded by a membrane envelope—containing surface glycoproteins and transmembrane glycoproteins—that is derived from the cell.

FIGURE 2: A schematic drawing of the M-PMV infection life cycle. During the early phase, the viral glycoproteins on the viral envelope bind to receptors on a mammalian cell, allowing the retrovirus to enter. The viral reverse transcriptase produces a double-

stranded cDNA provirus. Cellular mechanisms produce more viruses. During the late phase, the protein capsid is formed in the cytoplasm. Viral glycoproteins move to the plasma membrane of the cell. The protein capsid moves from the cytoplasm to the cell membrane and buds out of the cell by extruding the cell membrane envelope and its associated viral glycoproteins.

FIGURE 3: A schematic drawing of the gene organization and the protein products of M-PMV. Its RNA genome is composed of four gene regions—*gag*, *pro*, *pol*, and *env*. The *gag* region is translated into Pr 78, which is cleaved into capsid proteins p10, p16, p27, p12, p14 and p4. Due to a codon shift, the *gag-pro* regions are translated into Pr 95, which contains the proteins that cause precursor protein cleavages. Another codon shift causes the *gag-pro-pol* regions to be translated into Pr 180, which contains the reverse transcriptase enzyme. The fourth precursor, Pr 86-*env*, comes from the *env* gene region and is cleaved to produce the surface (SU) and transmembrane (TM) glycoproteins, gp 70 and gp 22, respectively.

FIGURE 4: A detailed diagram of the M-PMV *env* gene. The transmembrane (TM) glycoprotein, gp22, has three domains: the extracellular domain, membrane spanning domain, and cytoplasmic domain. The leucine zipper motif is found near the amino-terminus of the TM glycoprotein, near the beginning of the extracellular domain. The 38 amino acid residues of the cytoplasmic domain is shown. The TL15 mutation has 23 amino acids deleted, leaving 15 amino acids in the cytoplasmic domain.

FIGURE 5: The expression vector pSHRM15. The 13.8 kilobasepair plasmid contains the entire DNA copy of the M-PMV genome, which includes the *gag*, *pro*, *pol*, and *env* genes, under the control of the simian virus 40 (SV40) late promoter and the M-PMV long terminal repeat, providing the polyadenylation signals. Bpu1102 and NheI restriction enzyme sites were used in our cloning experiments.

FIGURE 6: The expression vector pTMO. The 8.5 kilobasepair plasmid contains the M-PMV *env* gene under the control of the SV40 late promoter. The pTMO vector was used as the cloning vector to make all of the mutation within the leucine zipper region of the M-PMV and to make the TL15 mutation. Bpu1102, NheI, and MroI restriction enzyme sites were used in our cloning experiments.

FIGURE 7: Mutations in the M-PMV leucine zipper motif intended to be made. These mutations were made by and were given these name designations by Brian Brody. These mutations were cloned into pSHRM15 and pTMO-TL15. Figure 10 shows the mutations that were confirmed to exist.

FIGURE 8: Cloning the M-PMV leucine zipper mutations into pSHRM15. pSHRM15 was partially digested with NheI and Bpu1102. The ~13.3 kilobasepair (kb) fragment was isolated. pTMO with the leucine zipper mutations was digested with NheI and Bpu1102. The ~0.5 kb fragment, containing the mutations, was isolated. Both isolated fragments were ligated together to obtain new pSHRM15-based clones with the leucine zipper mutations.

FIGURE 9: Cloning the M-PMV leucine zipper mutations into pTMO-TL15. pTMO-TL15 was digested with MroI and Bpu1102. The ~0.5 kilobasepair (kb) fragment,

containing the TL15 mutation, was isolated. pTMO with the leucine zipper mutations was digested with MroI and Bpu1102. The ~8 kb fragment, containing the leucine zipper mutations, was isolated. Both isolated fragments were ligated together to obtain new pTMO-based clones with the leucine zipper mutations and the TL15 tail mutation.

FIGURE 10: Mutations in the M-PMV leucine zipper motif confirmed to exist. After cloning the leucine zipper mutations in pSHRM15 and in pTMO-TL15, the new constructs were confirmed by restriction enzyme digestion and by dideoxy sequencing. Sequence analysis showed that three mutants—originally designated as LZ2C (I45V), LZ404 (I45V/L52E), and LZ402—did not have the mutations that were intended. All of these three “mutations” had the same L52V mutation.

FIGURE 11: Preliminary results of the reverse transcriptase (RT) assay. In this cell-free infectivity assay of infected HeLa cells, RT levels were monitored on days 3, 6, 10, 13 and 17 post-infection. Wild-type or mutant pSHRM15 virions were used to infect cells.

Weify Soong is a Senior biology major with a Mathematics minor. He is from Vestavia Hills, Alabama, and will be attending medical school next fall. Currently, he is stuck in the Phillips Science Building, feeling like a trapped lab rat and getting exposed to different kinds of biohazards and various doses of radiation.

Figure 1: Structure of an M-PMV virion

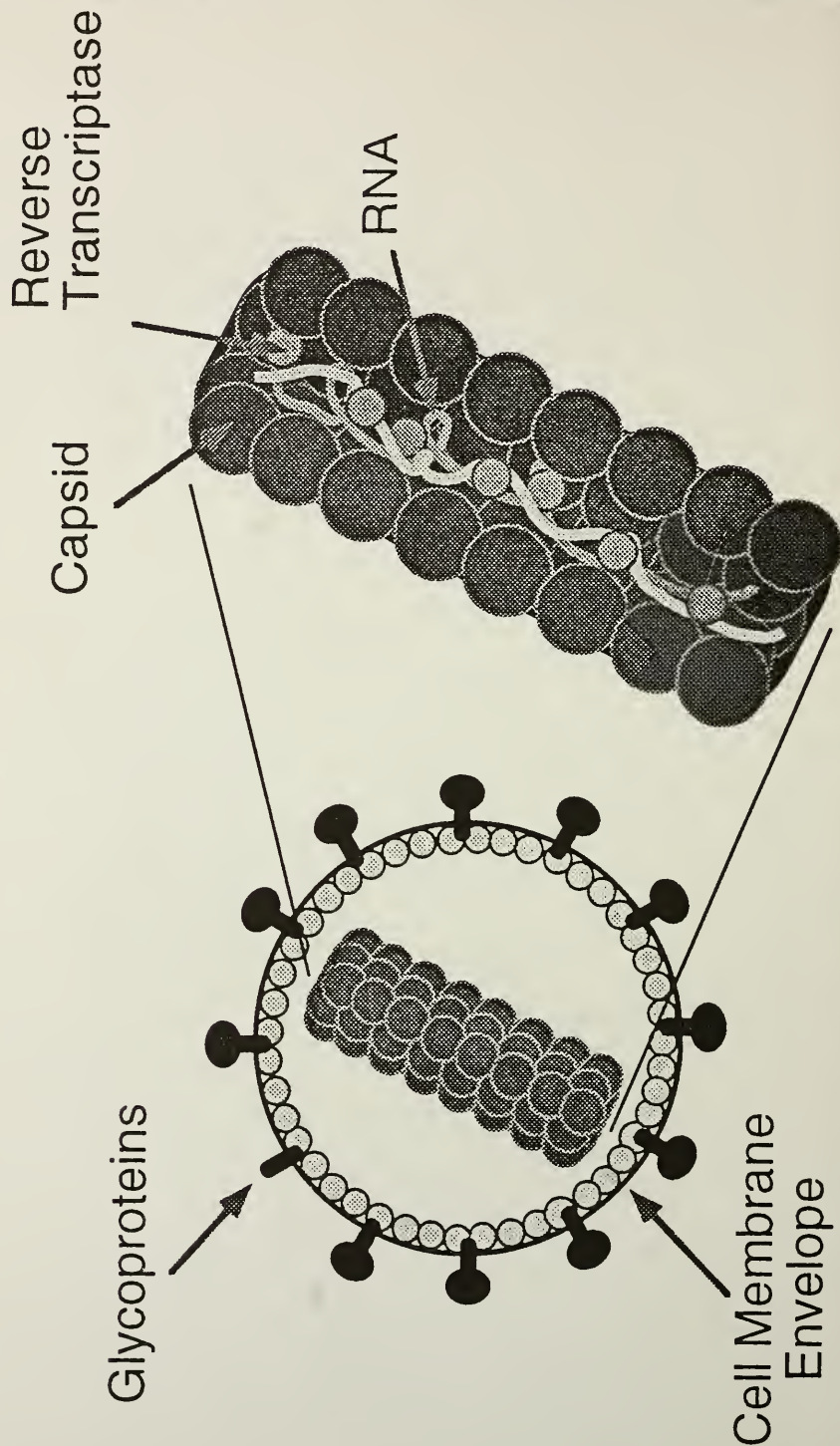


Figure 2: Infection Cycle of M-PMV

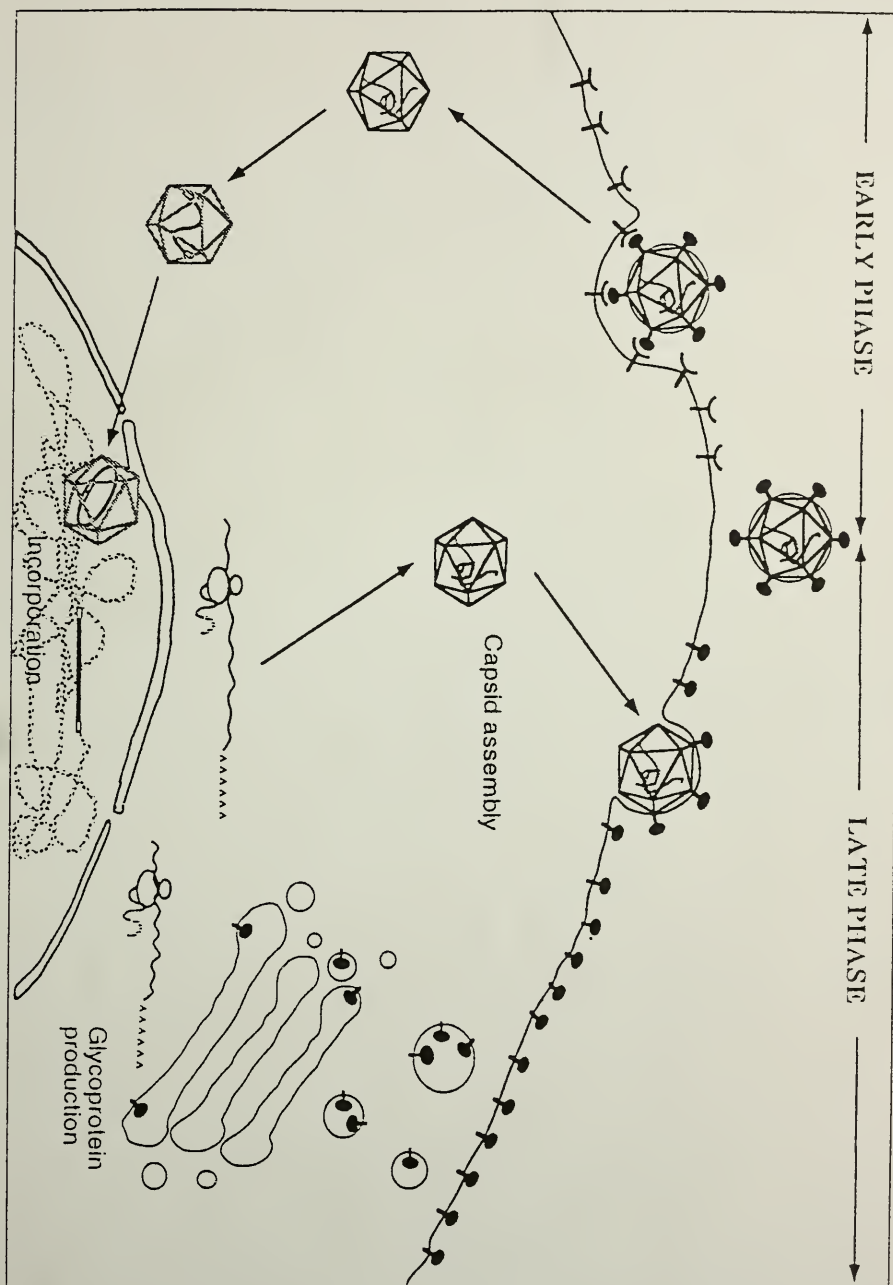


Figure 3: Gene Organization and Protein Products of M-PMV

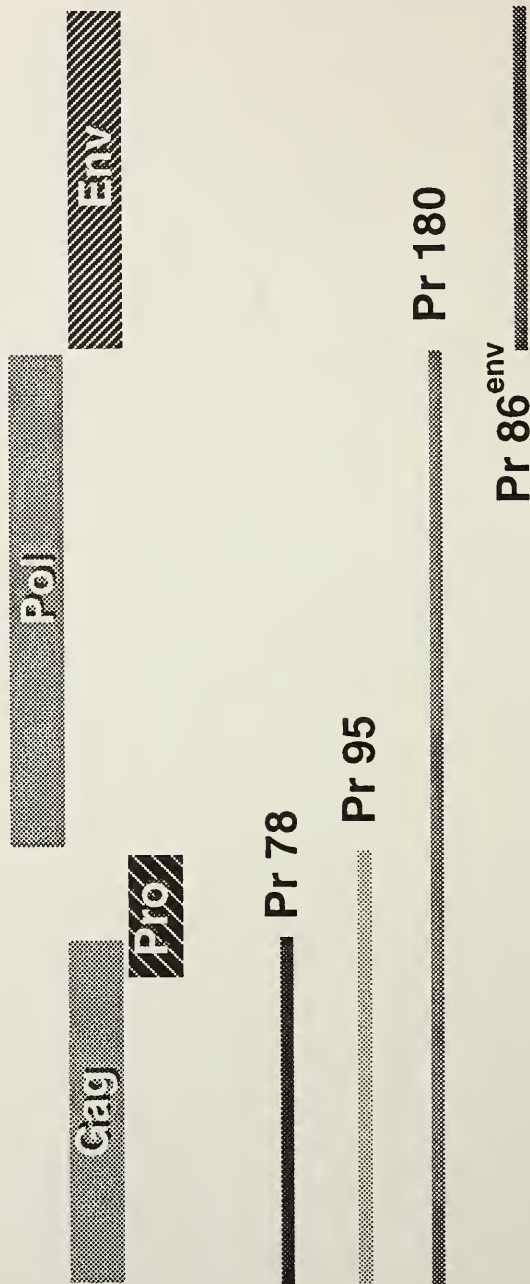


Figure 4: M-PMV env Gene

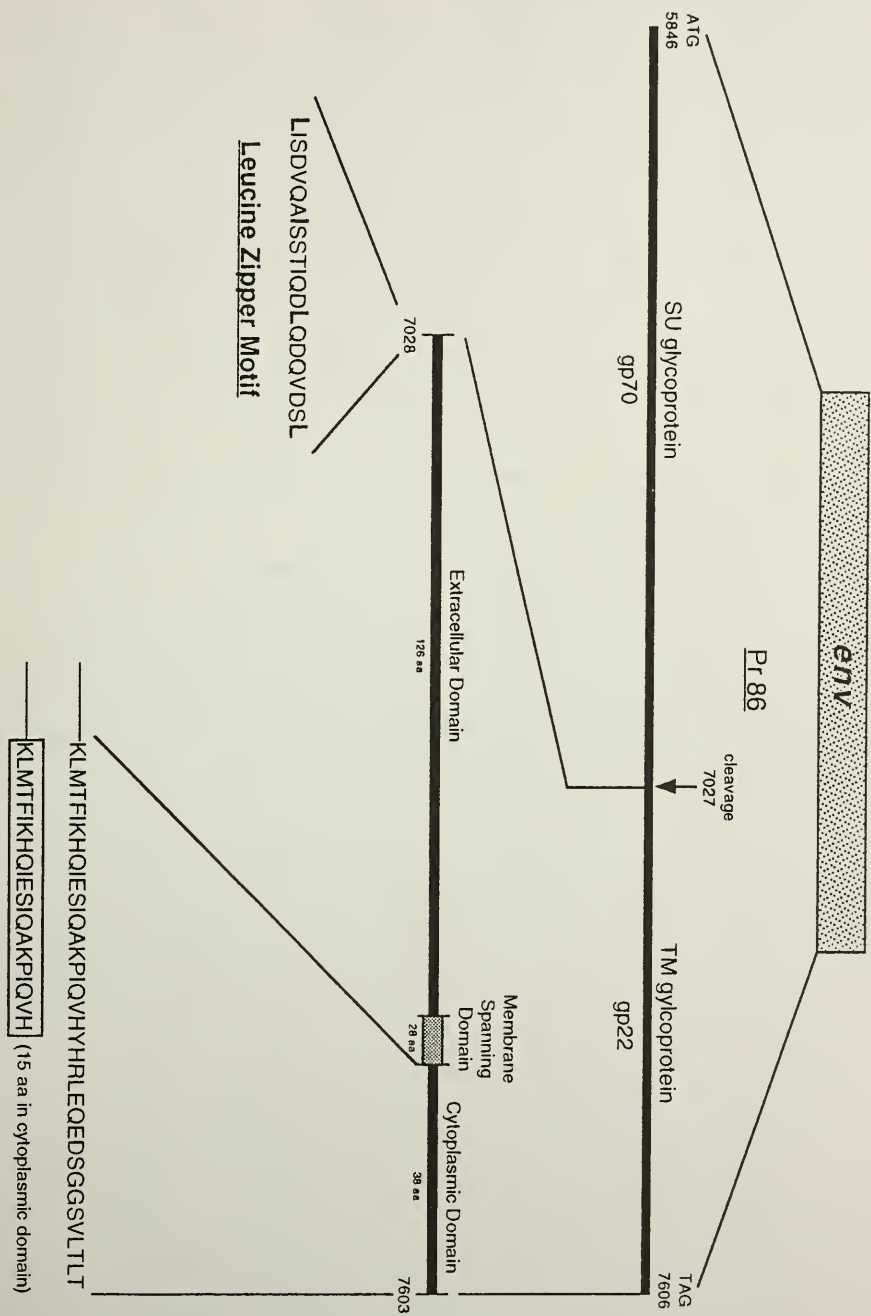


Figure 5: pSHRM15 expression vector

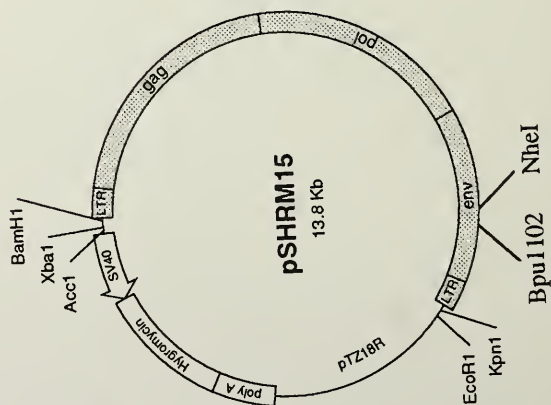


Figure 6: pTMO expression vector

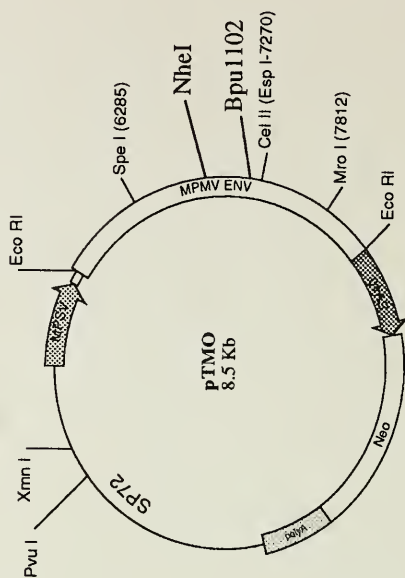


Figure 7: Intended M-PMV Leucine Zipper Mutants

Wild-type sequence:

L I S D V Q A I S S T I Q D L Q D D Q V D S L
 (37) (45) (52) (59)

Mutants:

1) LZ2C (I45V)

V

2) LZ2C/I6G (I45V / L52V)

V

V

3) G12 (GLU 12: I45E)

E

4) LZ404 (I45E / L52E)

E

E

5) LZ402

I S S T

Q D D Q

6) LZ401 (I45E / S47R / L52E)

E R

E

7) MK201

I S S T

I Q D D

Q D L

(insert) (52)

Figure 8: Cloning M-PMV Leucine Zipper Mutations into pSHRM15

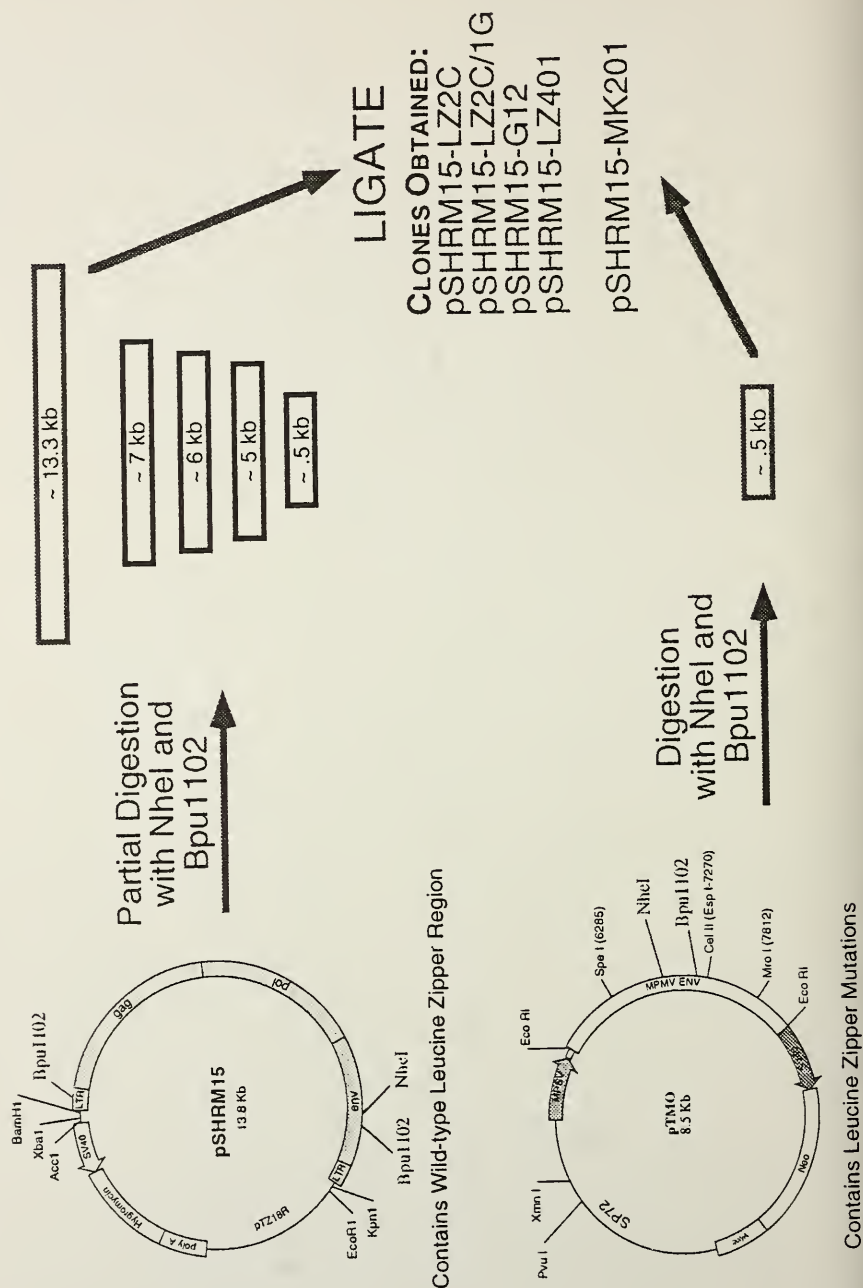
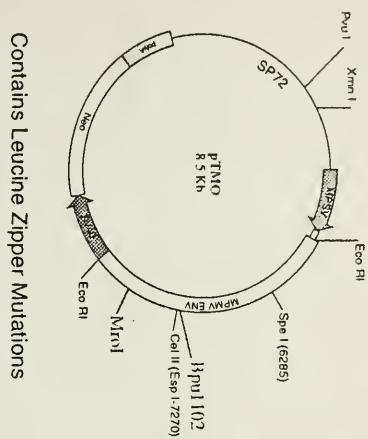
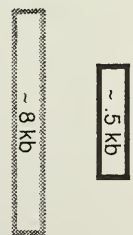


Figure 9: Cloning Leucine Zipper Mutants into pTMO-TL15

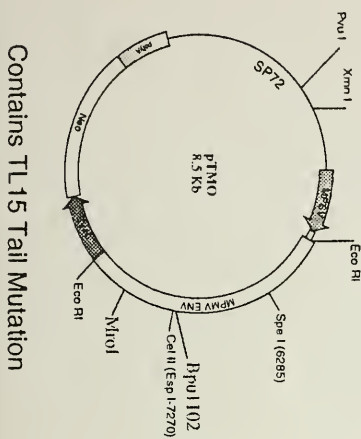


Digestion
with MroI and
Bpu1102



LIGATE

CLONES OBTAINED:
pTMO-TL15-LZ2C
pTMO-TL15-LZ2C/1G
pTMO-TL15-G12



Digestion
with MroI and
Bpu1102

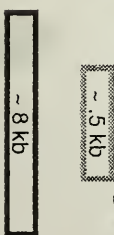
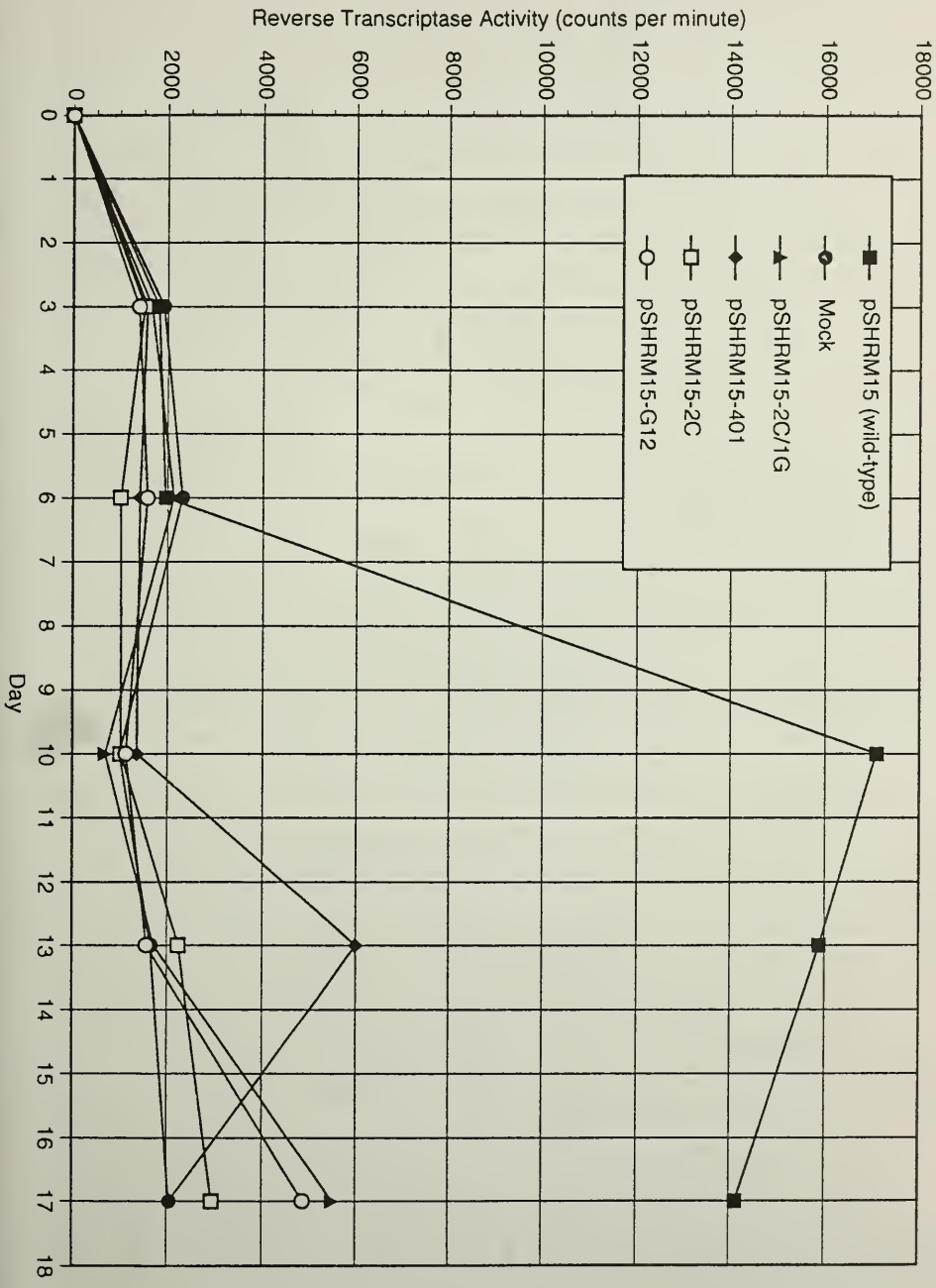


Figure 10: Confirmed M-PMV Leucine Zipper Mutants

Wild-type sequence:	L I S D V Q A I S S T I Q D L Q D Q V D S L	(37)	(45)	(52)	(59)
Mutants:					
Intended)	LZ2C (I45V)				
Found)	LZ2C (L52V)	V		V	
Intended)	LZ2C/1G (I45V / L52V)				
Found)	LZ2C/1G (I45V / L52V)	V		V	
Intended)	G12 (GLU 12: I45E)				
Found)	G12 (GLU 12: I45E)	E			
Intended)	LZ404 (I45E / L52E)				
Found)	LZ404 (I45E / L52E)	E		E	
Intended)	LZ402				
Found)	LZ402	I S S T	-- --	Q D D Q	V
Intended)	LZ401 (I45E / S47R / L52E)				
Found)	LZ401 (I45E / S47R / L52E)	E R		E	
Intended)	MK201				
Found)	MK201	E R		E	
Intended)		I S S T	I Q D D Q D L		
Found)		I S S T	I Q D D Q D L		

Figure 11: Results of the Reverse Transcriptase Assay



LAURA UNDERWOOD

Reading Lives in Cooking Books

A BROAD BUT careful study of autobiography opens up the definition of the term by recognizing that there is no strict formula for telling one's life story. In many respected, canonized texts the reader notices innumerable instances of authors bending facts, coloring details, and leaving out seemingly important information—all for the purpose of telling their stories in the way that they (think they) wish to. A search for objective "truth" in autobiography is relatively fruitless.

This futile search has led me to ask an important question: if "traditional" autobiographies contain such fabrications, why are they privileged and touted as examples for us to study and live by? It seems to me that we can learn just as much by reading other, more non-traditional (or unrecognized) forms of life stories. With this in mind, I have looked into my own life for what has been my most constant and prolific form of self-expression: cooking.

I have always felt the pull of the oven and the promise of cabinets full of bowls, pans, old reliable utensils, and various raw ingredients. There is not a single memory in my head of a time when my mother said to me, "Give me that spoon—you can't stir that!" or "Laura, get your hands out of the bread dough." Working in the kitchen has been an integral part of my growth process and has shaped my personality, so it is only natural that I consider cooking, and writing about cooking, to be a valid form of expression.

In his essay "The Underside of Bread: a Memoir with Food," Michael Frank writes that "food can be counted on to produce a sensation in time present that will duplicate a sensation from time past" (56). But it is not just the food itself that has such powers of recollection. Preparation and service are just as important. Recipes become meaningful because they are repeated and eaten over and over, or because they were perhaps prepared only once but with quite memorable results ("memorable results" often means fire, or

at least large quantities of smoke to make a house smell for days). Foods that are prepared only for certain occasions become "traditional," like the cranberry bread that my mother and I always make at Thanksgiving and Christmas. Michael Frank is right, but the implications of cooking and food are more complicated and extensive than he admits.

I know that I could tell my own story through the lens of the kitchen. In my childhood the kitchen was the place where my mother created wonderful meals and birthday cakes (part of her own story) while taking the time to teach me to knead bread. It is the place where I made the awkward mistakes of adolescence, breaking the double boiler and creating gargantuan messes. Now it is where I discover adulthood—finding independence in using my own techniques and ideas instead of/along with my mother's, pursuing my own creative interests (even when I know my father and brothers prefer their food fried or boiled senseless), and assuming responsibility for the smaller but inevitable messes I make.

Since I feel so strongly that stories of life can be told through the interactions of cooking and eating, it seems appropriate to turn to cookbooks as another form of autobiography (and one that can be read just as critically as a more conventional text like Benjamin Franklin's). I know that many cookbooks have a person's name attached to their titles simply because there are so many different styles of cooking and so many expert chefs. But there are also many cookbooks that contain more than just cooking directions; in introductions, accompanying essays, and notes following the recipes, the authors weave in stories of life that make the books much closer to autobiographies than to technical handbooks.

Rather than give a broad survey of these kinds of books, I have chosen to read two of them closely and critically, since I feel that such a reading is more conducive to a true understanding of their autobiographical aspects. The two books are quite different, although it is interesting to note that both of them are subtitled "Recipes and Reminiscences." The first is chosen because it is part of my own autobiography, one of my family's only "coffee table" books and a favorite of my mother's. The other comes from browsing through the cookbooks in the public library. What follows is an in-depth look at each one, with comparisons and conclusions drawn at the end.

Nathalie Dupree's Southern Memories: Recipes and Reminiscences is a beautiful book, full of pretty pictures and happy stories. A co-worker gave it to my mother for Christmas several years ago, and since then it has resided on our coffee table and made it into the kitchen only a few times (and then very cautiously, since splattering grease on it would be tragic). Its endpaper is a close-up shot of perfect white dogwood blossoms (not a one

shows brown bruising or withering) softened by a shadowy, grey-blue patina—a hint of what comes later.

In her "Introduction" Dupree defines a collective consciousness of which she is a part—"My South"—in images both nostalgic and stereotypical:

My South . . . is memories of the massive black babysitter who tenderly cradled me between vast bosoms while she played the piano and crooned the blues and I ate an angel biscuit smeared with jam. It is the sweet-smelling aroma of vines and gardenias and magnolias, the flowers tucked in the hair and décolletages of vain and beautiful women, wafting through screened windows, floating in glass bowls, and the smell of the oysters . . . a dank smell of darkness and secrets, prejudices and kindness. (viii)

In just two sentences Dupree manages to evoke over a half-dozen standard Southern images—Aunt Jemima, "the blues," biscuits, magnolias, Blanche DuBois, Gothic family mysteries, racial unrest, and our famous politeness.

These images are continued and added to in the "Introduction" and throughout the text. This is autobiographical in that she is writing about the place where she lives, and why she loves it and finds it fascinating. But Dupree succumbs to these images far too completely, often missing the chance to temper her stereotypes with reality. At the end of the "Introduction" she writes, "the South is my soul. It is the part of me that I can't change, can't get rid of, even should I want to" (ix). This strong feeling is common to many Southerners whom I know (including myself), and it seems to indicate that Nathalie Dupree loves the South for less shallow reasons than the ones so poetically drawn in the "Introduction." But evidence to support this is simply not present in the rest of the text.

The book is divided into chapters (for the various kinds of food) which tend to define what types of people would make or serve the recipes included in them. The first, second, and sixth chapters are entitled "Pick-ups," "Ladies' Lunches," and "Southern Hospitality." These three sections paint the image of the Southern society "lady," the belle who is "vain and beautiful" (viii). It is interesting that Dupree constructs this image, since her family moved to the South (Virginia) when she was in the first grade, and her father is by her own admission "a Yankee" (34). The Southern aristocracy is not truly her birthright, but Dupree links herself with it and manages to uphold it anyway.

One way that Dupree links herself with this tradition throughout her book is by calling on Martha Washington as her muse and one of the original Southern social belles. In the "Pick-ups" chapter, Dupree writes that the

"imperative to always have something to eat can be traced back to the tradition of unfailing hospitality and endless entertaining established by Martha Washington at Mount Vernon" (1). "Pick-ups" are foods to be eaten at any time and can always be offered to visitors—assuming that Southerners of the late twentieth century have the energy to keep a stockpile of homemade goodies and the time to share them during leisurely, unannounced visits. Of course, this problem can be partially solved if your town "has a caterer renowned for 'the best' cheese straws," of which "well-to-do Southerners are rarely without a supply" (2).

While Dupree insists that pick-ups are generally unsophisticated fare, the picture beginning this chapter tells a different story. It covers a full page and is highly stylized (as are most of the book's pictures). Its caption describes it as "a casual pick-up buffet" (1), but it shows perfectly prepared, arranged, and garnished foods on a silver tray resting on a linen cloth covering an antique table. The food is accompanied by a frosted silver pitcher and silver tumblers of what appear to be mint juleps. This whole scene is arranged on a porch with huge columns and rocking chairs. It is hardly casual and hardly the norm for modern Southerners, who tend not to live in antebellum mansions.

This stylized nostalgia for a South and Southerners that no longer exist (and may never have existed) continues in the chapters on "Southern Hospitality" and "Ladies' Lunches," both of which convey messages that are hard to reconcile with what I know of Southern women and Southern life. In "Southern Hospitality" Dupree writes that she "first came to understand the Southern notion of entertaining" at Mount Vernon, which is near her childhood home; we learn that "Martha [Washington] entertained so frequently that the story goes she served a ham a day and had enough guests to eat it all—much to the annoyance of . . . Abigail Adams, who didn't feel able to entertain so lavishly" (97). Just as Martha Washington set a precedent that Abigail Adams was unable to follow, so does Nathalie Dupree construct a South and a brand of Southern femininity that cannot be achieved and are barely real.

I know this to be the case because I have observed my own mother, an expert cook and career woman, reading this cookbook in snatches on weekends and saying, "Someday I'm going to try these recipes." She looks at the beautiful pictures, and then at our perpetually messy house, and it almost seems that Nathalie Dupree makes her more tired than she was before she picked up the book.

I also know that Dupree's realm of "Ladies' Lunches" is one in which fewer and fewer Southern women belong. She describes these affairs as "as symbol of the strength of the Southern woman," since "the kitchen was al-

ways the domain in which [she] could exercise control . . . when all other avenues were closed to her" (17). And according to Dupree, these luncheons are still special for numerous social occasions, when "the fare is sophisticated, men are banished, and women reign supreme" (18). It is as if brutish Southern men cannot participate in anything "sophisticated," and fragile Southern women cannot achieve any kind of control without "banishing" those same men. I know that this is not true. My mother, a public health administrator, supervises hundreds of people all over southern Alabama, and it stands to reason that Nathalie Dupree, author of several cookbooks and creator of television cooking shows, is not altogether powerless. So why does Dupree subvert her own persona (as well as that of many other strong Southern women) in favor of a delicate, submissive one?

In the very next paragraph Dupree tries to save herself by writing that "indeed, the tradition of ladies' lunches is not the exclusive province of elegant women with time for leisure"—but the redemption comes too late (especially since one of the alternative images she provides is that of "a young woman and her beau's mother eating crab salad and tassies under the dogwood blossoms") (18). So far, it seems that this entire book is written for those "elegant women" who wish to believe that their well-dressed South is still alive in the next generation of belles.

This replacement of reality with nostalgic stereotypes and glossy prints continues in the chapters devoted to "Dishes of Fishes" and "Comfort Foods." These sections contain recipes for what many consider to be traditional Southern foods—turnip greens, corn bread, etc. But what Dupree de-emphasizes and almost overlooks is the dire poverty that surrounds the origins and developments of such foods. In the introduction to "Dishes of Fishes" she writes, "the importance of fish in Southern cuisine is evident even in the earliest Colonial cookbooks" (33). She leaves out why it is important, but it is logical that fish and other seafood were important because they required no feed or care—only a bit of last-minute skill to catch them—to yield good, free food. This is still true in the South (though now the cost of equipment and sometimes a fishing license must be figured in). I see proof of it every time I drive the back roads at home and see trucks parked beside small bridges over creeks, and every time I see a cast net thrown off a pier. A cane pole can provide a few hours of quiet recreation and a mess of bream for supper.

Dupree's inability to confront the poverty of the South continues in the other chapter discussed here. "Comfort Foods" provides a conflicting picture. Her text is more honest here, acknowledging that "during lean times" both blacks and whites "cooked the same thing—the foods that were in season or that they put up themselves" (54). Her next sentence is especially

revealing: "we didn't use our cash crop money for daily eating if we could avoid it" (54), implying that perhaps her family experienced the hard times avoided by only the wealthy and more "aristocratic" Southerners. That sentence might be proof of Dupree's real position in the South and evidence that she knows there is more to Southern life than society and magnolias. But that is the only such sentence in the whole book and the only one that alludes to something challenging and not particularly pretty.

This glimpse of something deeper is belied by the photograph that accompanies the text. It is of cornbread and buttermilk, a legendary "comfort food," in an antique pewter bowl. The bowl is on a blue-checkered tablecloth next to a silver spoon, and the buttermilk is being poured from an antique blue-and-white patterned pitcher. This stylized image is in direct conflict with my own knowledge of this food. My daddy has always told the story of a friend who worked with him in my grandfather's dairy barn. The friend would fill up on milk before leaving for home so that he wouldn't take a share of supper away from his brothers and sisters—and that supper was nearly always cornbread and buttermilk. I know this "comfort food" is as much a symbol of poverty as it is a cherished memory, but Nathalie Dupree does not seem so willing to admit it.

Since I have gone to so much trouble to point out all the flaws and inconsistencies in Dupree's text, it seems only fair to acknowledge that it contains some honesty as well. My favorite recipe (though I have not yet tried it) is for "Coconut Squash," one that Dupree stumbled upon in the following manner:

I am hopelessly nearsighted and once, when I was in a rush and distracted by the phone, I looked into the freezer and grabbed coconut rather than breadcrumbs. I didn't discover my mistake until I tasted the finished dish. It was great, so I served it and keep serving it. (83)

Dupree's honesty in admitting her clumsiness and her ability to turn a bungle into good food are worth reading about. But this is the only recipe in the book that carries such a story.

Another glimpse of reality comes in the "Sunday Family Dinner" essay, which Dupree concludes with a description of what Sunday dinner is truly like for her now. Even though she and her mother live an hour apart, they still get together for this meal, and "with the use of a microwave and freezer" they can have many of the same dishes that fueled the big, boisterous gatherings of the past (119). This is an acknowledgement that families, once sacred and bound almost unbreakably, move apart in this world, although the spiritual ties remain. And even though she might like to prepare everything in the same way that Southern women did generations ago,

Dupree freely and unashamedly admits to making use of the technical developments that make modern life more convenient. In this brief description I can glimpse the Nathalie Dupree who cherishes the past but does not try to falsely re-create it, and is reconciled to the changes that have taken place in her South.

But such glimpses do not appear often enough to keep this book from drifting into the realm of autobiographical works that distort and conceal. Dupree combines lyrically nostalgic text with highly stylized pictures of her own conception—on the “Acknowledgements” page she thanks her photographer for “captur[ing] my mental image of food” (211)—to give a misleadingly incomplete picture of the South and Southerners. By scripting herself as part of this false collective she creates a life story that cannot be entirely trusted and alienates herself from the critical Southern reader.

A very different story is to be found in From My Mother's Kitchen: Recipes and Reminiscences by Mimi Sheraton. This book is more intentionally autobiographical than Dupree's, which may explain some of those differences. But comparisons to Dupree have their place at the end of this paper—for the moment, Sheraton merits a more singular examination.

From My Mother's Kitchen contains the myriad of recipes that were cooked in Sheraton's Jewish-American home. In her “Introduction” she described how she decided to write this book.

Having moved away from home, she missed her mother's cooking and was afraid that many of those treasured recipes, which were recorded only in her mother's mind, would be lost in the same way that her grandmother's were. So Sheraton began wrestling with her mother to write down and collect recipes whose ingredients had never been quantified—a difficult process during which her mother even offered to pay Sheraton not to write the book:

she begged me to drop the project entirely, knowing it was going to become detailed and bothersome. “I'll pay you not to do the book,” she said. “How much?” I asked, certain I would be the first writer to be subsidized for not producing. “Fifty dollars,” she answered, obviously her estimation of my worth on the open market. (1)

This exchange sets up the mother-daughter dynamic that runs through the entire book, and it is also a significant way to begin a work of this nature. It is entirely possible for the reader to assume that inconvenience is not the only reason that Sheraton's mother wants her to abandon the project.

Despite her mother's irritation, Sheraton continued collecting recipes and found herself with enough material for a “full-fledged cookbook” (1). During this process, however, “it became obvious that recipes alone would

have left the book incomplete. So many of the dishes were more than what they were" (1). This discovery that the recipes are more than just food to fuel a body is part of the basic assumption underlying the reading of cookbooks as autobiographical works. Sheraton's acknowledgement of this on the first page of her book is important.

The rest of the "Introduction" provides a sketch of Sheraton's family and her neighborhood—solid background for the recipes to come. Like me, Sheraton "cannot remember a time when [she] did not know how to cook" (4). Hers was a unique food experience, since her family is Jewish but did not keep a kosher house. As a result, Jewish-European traditions came together with American dishes to create a cross-cultural kitchen (5).

Sheraton alternates chapters of recipes with stories from her childhood. This technique is especially effective because the essays deftly combine food memories with other aspects of daily life in Brooklyn. The first essay, "Washington Market," is about the times when Sheraton was allowed to go to work with her father, a wholesale produce merchant. Because of his profession she learned much about fruits and vegetables on these days. His work also meant that the family ate a wider variety of produce than most of their neighbors, including "eggplants and artichokes" that were seldom seen in their neighborhood markets (19). When her father brought home such delicacies her mother would simply "adjust her dinner menu to include the latest offering" (19). These culinary adventures surely helped prepare Sheraton for her position as food and restaurant critic for The New York Times.

The "Friday Night" essay elaborates on what Sheraton writes earlier in the book about her home combining kosher and American foods and traditions; "religion at our house was practiced more in the manner of folk customs, rather than the strict, ceremonial rituals of Orthodoxy" (76). Her mother would prepare all day Friday for the Sabbath eve dinner, cleaning the house and cooking a meal based on her own ideas (almost invariably, soup and chicken) rather than kosher regulations. And though her mother "lit candles and always set out braided loaves of challah bread . . . she never said prayers when lighting those candles or cutting those loaves" as her grandmother did (77). Now Sheraton has inherited some of the heavy brass candlesticks that held those candles, but she lights them whenever fancy strikes her, taking one step further the practice of adapting tradition to suit one's own ideas and lifestyle.

"The Joys of Being Sick in Bed" is a cheerful account of a childhood memory defined by the various drinks and foods that accompanied different stages of illness. Sheraton could always determine her status by what she got to eat: "my progress in recovering could be measured by the food

my mother served" (206). Early stages of illness required teas, either plain or "a flowery, rosy brew of dried raspberries," or "a clear, sunny, gently perfumed camomile, or bosky sassafras" (206). Fever or the heat of too many blankets and hot water bottles brought iced fruit juices. Toast came next, and Sheraton writes that "I knew I was close to recovery when I got the toast I liked best—almost-burned rye bread toast covered with salt butter;" soups and gentle egg dishes followed, but only when she was "more than half well" would her mother give her milk (208). These times were very nurturing for Sheraton, for she "felt cured, and very well cared for and loved" by the time she was well enough for meat and potatoes (208).

Of course, not all Sheraton's essays are quite so idyllic. "Sunday Dinners" paints a picture of her mother as a woman who probably felt somewhat pressured in her unending role as cook for a big hungry family. The family ate a large breakfast, then began the wait for the main meal, later in the afternoon—"each week [her] mother complained, threatening to serve it at five in the evening ('like normal families who have only two meals on Sunday . . . why do I have to cook three?'), but each week there it was . . ." (133). As her mother cooked, she loved to listen to Yiddish language stations and other radio programs, and Sheraton's quotations from these are worth duplicating here:

the Horn & Hardart Children's Hour ("Less work for Mother, just lent her a hand") with its young performers; Arthur Tracy, the Street Singer ("Marta, rambling rose of the wildwood . . ."); the A & P Gypsies (Play Gypsy, dance Gypsy . . .") (134)

These fantasies of helpful children and free characters contrast starkly with her mother's activities. Sheraton herself, or her father or brother—"whomever [her] mother could catch and press into service"—reluctantly made the mid-morning bakery run that provided fresh bread for the meal (134), but that is all the help they gave. When the dinner was finally ready, her mother still could not relax and was constantly getting up and down, running to the kitchen in the typical mothering gesture of providing more for the family.

After dinner the rest of the family napped, read the newspaper, or visited with relatives and friends, but they always reconvened "in time for the third meal, the supper [her] mother swore she wouldn't bother with next week" (135). Of course, Sheraton's mother may have complained so vehemently in fun, but it would not have been an issue at all if there were not some basis in reality. And though the adult Sheraton looks back fondly on this Sunday dinner tradition, she makes no mention of enacting this labor of love herself.

Though Sheraton's descriptions of her mother and her family are gen-

erally contented and admiring, she is honest in writing about the conflicts and embarrassments that sometimes came between them during her adolescence. These incidents give insight into Sheraton's growth as an individual—insight that adds depth to the autobiographical aspect of the book.

These moments occurred often at the fish market, where Sheraton's mother "was adamant about . . . freshness" to the point of haggling with merchants and even reporting one to the health department for selling contaminated fish; when the health inspector burned the merchant's stock, she felt vindicated (111-12). In a classic example of the wisdom gained through maturity, Sheraton writes that "though as a child I found her performance embarrassing, it's one I imitate now for the same reason she did" (111).

A similar transformation involved Sheraton's opinions about the bread she ate in her youth. In the essay "Summer," she recalls being embarrassed by the big, uneven slices of rye bread that her mother sent with her in sandwich form to the beach; loaves of rye bread were tapered and did not slice perfectly, so she "wished for neat, squared-off sandwiches on packaged white bread" which seemed "classier" and more American (109). But as an adult Sheraton longs for that same rye bread, having overcome childish perceptions of what is "classy" in favor of embracing the offerings of her own culture.

Another example of Sheraton's growth process (minus the embarrassment) can be seen in her feelings about soup. As a child she disliked the soup course of a meal because it seemed "boring and bothersome" to negotiate an even portion of the liquid and solid ingredients, and because it took what seemed an endlessly long time for the soup to cool enough for her to eat it. But growing up has improved her patience and motor skills, and now Sheraton writes that "if I could remember the precise moment that I began to love soup, and especially soup that is volcanically hot, I think I could mark the turning point from childhood to adulthood" (53). Maturity gives Sheraton the capacity to appreciate things even more if getting them requires a bit of skill.

Although I have elaborated on how the essays and introductions accompanying Sheraton's recipes show the growth of her personality, the recipes themselves are even more revelatory, especially concerning her relationship with her mother. In this book they are not merely directions for cooking food. They become evidence of the conflicts, stalemates, and agreements between two women who are both very good at the same thing.

Since these revealing tidbits occur many times throughout the book in introductions and notes to the recipes, I will select just a few examples for this paper. The first is indicative of the level of honesty in this book. Sheraton includes her mother's recipe for Calf's feet, an appetizer served only at their

fancy Friday night meals. Sheraton loathed it so much as a child that she left the room while it was being eaten, and she "can't say [she] like[s] it entirely even now . . . but the sauce is wonderful" (39). She does not eat the dish herself, but includes it because it evokes her childhood and is enjoyed by the rest of her family—an indication of her willingness to include things that are part of her life despite their unpleasant nature.

Another such note illustrates the rifts that exist between mother and daughter despite the gaining of maturity and respect.

After a recipe for oyster stew, Sheraton includes this variation: "I like a dash of cayenne pepper or Tabasco sauce added with the sherry, a substitution my mother considered a sign of madness" (68). There are several times in the book when Sheraton's mother considers her daughter to be slightly 'mad,' but this one indicates Sheraton's ability to expand on what her mother has taught her, even if her mother disagrees with the additions. She is not afraid to alter her mother's recipes if her own taste calls for it. This shows self-confidence and independence.

This independence is carried one step further in a rare instance where Sheraton criticizes her mother's cooking. In "Soup Chicken and the Things that Happened to It," Sheraton tells without fear or remorse of her mother's attempt to serve a chicken after it had been boiled for the ritual Friday soup (which was only broth). She would sprinkle the chicken with spices and brown it in the oven, and Sheraton admits that "the result was one of the worst dishes I have ever eaten . . . It was like paprika-flavored balsa wood, chokingly dry" (136). Reaching a point at which she is able to publicly criticize her mother's cooking is a milestone for any daughter, and especially one who cooks in her mother's footsteps.

But these recipes do not just polarize Sheraton and her mother—they are evidence of reconciliation as well. In the recipe for chicken soup, Sheraton discusses the addition of dill as a garnish: "my mother felt it was a mistake to cook the dill in the soup, as it had a souring effect, and having tried it once, I must report she was right" (58). A similar (though reversed) affirmation accompanies a recipe for sweet and sour cabbage. Sheraton adds grated apple to the dish, "one of the few innovations [her] mother approved" (188). These comments are evidence that the two women have confidence in each other's abilities as well as their own. They can be equals in the kitchen now, sometimes disagreeing but always knowing that they are both superior cooks.

Notes like these help make From My Mother's Kitchen the honest autobiography that it is. Sheraton manages to combine happy memories with real evidence of familial relationships and personal growth. She does not attempt to conceal disagreements or foolishness from her past. Perhaps this

is what is lacking in Nathalie Dupree's Southern Cooking—the real stories of how a recipe came into existence, instead of stylized nostalgia that paints only a superficial picture.

It does seem that the two books can be compared on the basis of how Mimi Sheraton and Nathalie Dupree present themselves as individuals. Dupree is hidden (just like the dogwood blossoms on the book's endpaper) behind a facade of stereotypes and prettiness that she may or may not be a part of. She forsakes her own identity in favor of defining a "Southern" identity, but this fails because she plays up only the expected and now-defunct images of Southerners. Mimi Sheraton makes no such attempt at defining an entire Jewish-American community. She is more successful at autobiography because she allows herself to appear fully, with mother-daughter conflicts and adolescent embarrassment attached. Her lack of artifice is refreshing in a canon of autobiographers who hide behind ideologies and attempts at perfection. In From My Mother's Kitchen Sheraton gives me what I want from autobiography: the story of one person's life, with all its idiosyncracies, connected with something real—the cooking of good, nourishing food.

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Laura Underwood is a Senior English Major who loves to cook, sing, and listen to people with good Southern accents. In the fall she will begin graduate studies at the University of Alabama, but only as a brief diversion from the path towards her ultimate goal -- building an authentic wood-burning, stone-and-clay bread oven in her backyard.

GLENN L. SUMNER, PH.D.

*Intertemporal Benefit-Benefit Analysis
With Missing Markets:
Tradeoffs Between Environment and Development.*

THIS PAPER PRESENTS an intertemporal behavioral model of the tradeoffs between economic development and environmental concerns. One thing that makes this model different from previous models is the fact that an attempt has been made to integrate the cumulative level of environmental damage into the decision-making process. It is entirely logical that economic actors consider the current state of the environment when evaluating decisions which impact the environment. Yet previous models have not yet attempted to incorporate it. This model attempts to incorporate the current cumulative state of environmental damage into the opportunity cost of the decision function. Instead of the traditional cost-benefit approach, this model presents an intertemporal benefit-benefit approach, whereby the economic decision-maker is faced with enormous future benefits from environmental preservation, but due to the discounting effect of opportunity costs, these benefits have a much smaller perceived present value. This present value can be outweighed in comparison by much smaller current benefits of environmentally damaging economic development. Benefit-benefit analysis yields an equilibrium level of environmental damage. Although this equilibrium level also occurs with the more common cost-benefit approach, benefit-benefit analysis may provide important insights into the decision-making process of polluting entities, and may also explain why LDC's with higher opportunity costs often exhibit some of the highest levels of economic damage. These results lead to the surprising conclusion that perhaps the answer to environmental destruction in least developed countries may be more development, not less, as some environmentalist groups would postulate.

INTRODUCTION

In increasing numbers economic development scholars are beginning to realize that something has begun to go wrong with many of the development projects in the least developed countries (LDC's). It is rapidly becoming apparent that Kenneth Boulding may have been correct, when, he stated (1966) that the linear approach of economics textbooks may not be enough to explain the real world. In the textbooks, the economy consists of a consumption and a production component. Boulding reminded the academic community that these items are not independent of the supply of natural resources. He replaced the linear economy with a more circular flow, one which was inextricably linked to natural resources. Additionally, in the decades since 1966, it has become more and more apparent that the earlier enthusiasm of scholars for rapid industrialization may have been short-sighted. Early belief that technology would solve all problems is being replaced with a realistic re-evaluation of earlier thinking. Such re-evaluations are bringing Rostow's classic, *The Stages of Economic Growth: A Non Communist Manifesto* (1961) back to serious academic credibility. Rostow's theory, which received little praise when first published, was that certain stages of economic growth could not be rushed, but that a society had to go through these stages before industrialization could be accomplished.

His theory was largely ignored during the previous few decades, when both academics and politicians were believing that technology would conquer all difficulties, and that this technology would also provide short-cuts to circumvent the need for such stages. As time has passed, however, this technology has fallen short of its goals. In many cases, large scale damage to the environment, culture and equality of income distribution has occurred as a result of attempts to find "short-cuts" to industrialization.

This paper attempts to address the difficult theoretical challenge presented by tradeoffs between economic development and the environment. In the next section of this paper, some theoretical difficulties are discussed, and an elementary theoretical model is offered, which seeks to explain actual behaviour of the microeconomic decision-making entity in one of these countries.

THE THEORETICAL PROBLEM

There are several objections to attempts by researchers to develop economic solutions to the problem of damage to the environment. The first is an irrationality argument, which states that it is irrational for individual

market participants to worry about his or her individual contribution to the destruction of the environment, since that contribution is effectively zero.¹

This can easily be shown by first examining the following general utility function:

$$U = F(T(D_t), D)$$

$$\frac{\partial T}{\partial D_t} < 0$$

where T = time the planet lasts,

D = incremental damage to the environment, and D reduces T ,

D_t = total damage to the environment, and is a function of D .

Taking the total derivative of U and set equal to zero:

Now let the change in D_t with respect to D equal $1/N$, where N equals the number of economic decision-makers or participants.

$$\frac{\partial U}{\partial D} = \frac{\partial F}{\partial T} \frac{\partial T}{\partial D_t} \frac{\partial D_t}{\partial D} + \frac{\partial F}{\partial D} = 0$$

When the economic decision-maker is a world government, then $N=1$, and

$$\frac{\partial U}{\partial D} = \frac{\partial F}{\partial T} \frac{\partial T}{\partial D_t} \frac{1}{1} + \frac{\partial F}{\partial D} = 0$$

When the economic decision-maker is an individual, however, then N approaches infinity and $1/N$ approaches zero. Therefore,

$$\frac{\partial U}{\partial D} = \frac{\partial F}{\partial T} \frac{\partial T}{\partial D_t} [0] + \frac{\partial F}{\partial D} = 0$$

This means that the rational individual will not worry about his or her individual contribution to the destruction of the environment, since that contribution is effectively zero.

From a policy perspective, it is quite evident that the larger the economic unit being considered, the more important environmental concerns are to that unit, and vice-versa. This leads to an important question for the

policy-maker. How can economics deal with the individual decision-maker, and still provide a rational model of behavior for the usage of policy-makers?

Not only does the irrationality argument create a theoretical problem for researchers, but it also is not the only objection that can be raised against attempts to find an economic solution to the difficult problem of the destruction of the environment. Daniel Bromley, for example, pointed out that in a real-world scenario, one must realize that the market system will not produce an optimal solution, not because the market fails, but because the market is incomplete. In other words, the decision to pollute involves "intertemporal externalities," which "are characterized by missing markets in which future generations are unable to enter bids to have their interests protected." (1989, p.181) Because some of the interested parties (in this case, future generations) are unable to express their interests in a market system, a market system will not be able to arrive at a solution that is mutually beneficial to all generations, both current and future. In the words of Bromley, "when the present stands able to act without regard to the interests of the future then the present has privilege and the future has no rights." (ibid., p.181)

THE MODEL

With these previously discussed theoretical difficulties firmly in mind, this paper attempts to provide a model of actual market participant behavior. This model presents a rational model for individual behavior, but does not rely on a market bidding process. It is instead simply a descriptive model of individual behavior, which hopefully will present policy-makers with a less objectionable starting point in understanding the problem of tradeoffs between environmental concerns and development concerns.

One thing that makes this model different from previous models is the fact that an attempt has been made to integrate the cumulative level of environmental damage into the decision-making process. It is entirely logical that economic actors consider the current state of the environment when evaluating decisions which impact the environment. Yet previous models have not yet attempted to incorporate it. This model attempts to incorporate the current cumulative state of environmental damage into the opportunity cost of the decision function.

Also making this model different is the fact that this descriptive model is not a cost-benefit analysis. In other words, it does not compare social costs versus economic benefits (as would traditionally be the case)—since such a comparison brings in the irrationality objection. Instead, the model

compares benefits versus benefits. This benefit-benefit model begins with a realization that individual microeconomic market participants are faced with a choice between short-run benefits which are immediate and readily identifiable, and long-run benefits which are extremely large yet their value today may be perceived to be smaller. Within this time-value framework, the individual also considers the current cumulative level of environmental destruction, and therefore this model attempts to incorporate this level into the decision-making process.

Basically, market participants are faced with the choice between a short-run benefit from environmentally destructive behavior today, or with the long-run benefit of leaving a livable environment to the next generation.

Now, let the value of environmental and cultural preservation today equal to e and

$$\epsilon = e^{-\theta t} \beta$$

where q = opportunity cost rate and

$$\theta = e^{-zk}$$

k = a discount rate

b = benefit value to the next generation, which is a very large number,

t = time until the next generation,

z = cumulative amount of environmental damage, which we will assume to be reversible.

When the cumulative environmental damage (z) is large, so is the value of environmental and cultural preservation today. The reverse is also true; when the cumulative environmental damage is small, so is the value of environmental and cultural preservation today.

This long-term future benefit, as it is valued today, is weighed against the short-term benefit of environmentally destructive economic growth today.

The short-term value of economic growth with accompanying environmental damage is also related to the current cumulative level of environmental damage (z), and is represented here by the symbol a .

$$\alpha = b e^{-z}$$

Where b = the economic benefit today.

As the amount of cumulative environmental damage (z) increases, the short-term benefit of environmentally damaging behavior (a) declines.

Now, let the perceived net benefit of bad environmental behavior be equal to f , and

$$\phi = \alpha - \epsilon.$$

Environmentally damaging behavior will occur when $f > 0$ or $[a/e] > 1$.

There will be some "optimal" (z^*) level of environmental damage. This statement of an "optimal" level of environmental damage is hardly normative, of course! It is instead merely a statement of a positive economic theory which suggests that there is some equilibrium level of environmental damage that will naturally occur. Perhaps this optimal level, given certain discount rates—would normatively be perceived as too high, but it is interesting to note that this theory suggests that at some point, the long run (e) and short-run (a) benefits will be equal, and this point will be one of stability, once it is found.

A more mathematical approach should be used to determine the behavior of f to changes in z , and also to verify the signs of the slopes of a and e .

Now, let

$$f = F(a, (z, u), e(q(z, k), t))$$

t = other factors, such as per capita income or voting rights, etc. (held constant)

u = other factors, such as per capita income or voting rights, etc. (held constant)

k = an opportunity cost (held constant)

with all other variables remaining as previously defined.

Taking the total differential of f ,

$$d\phi = \frac{\partial F}{\partial \alpha} \left[\frac{\partial \alpha}{\partial z} dz + \frac{\partial \alpha}{\partial u} du \right] + \frac{\partial F}{\partial \epsilon} \left[\frac{\partial \epsilon}{\partial \theta} \left(\frac{\partial \theta}{\partial z} dz + \frac{\partial \theta}{\partial k} dk \right) + \frac{\partial \epsilon}{\partial \tau} d\tau \right]$$

$$d\phi = \frac{\partial F}{\partial \alpha} \left[\frac{\partial \alpha}{\partial z} dz + \frac{\partial \alpha}{\partial u} du \right] + \frac{\partial F}{\partial \epsilon} \left[\frac{\partial \epsilon}{\partial \theta} \frac{\partial \theta}{\partial z} dz + \frac{\partial \epsilon}{\partial \theta} \frac{\partial \theta}{\partial k} dk + \frac{\partial \epsilon}{\partial \tau} d\tau \right]$$

$$d\phi = \frac{\partial F}{\partial \alpha} \frac{\partial \alpha}{\partial z} dz + \frac{\partial F}{\partial \alpha} \frac{\partial \alpha}{\partial u} du + \frac{\partial F}{\partial \epsilon} \frac{\partial \epsilon}{\partial \theta} \frac{\partial \theta}{\partial z} dz + \frac{\partial F}{\partial \epsilon} \frac{\partial \epsilon}{\partial \theta} \frac{\partial \theta}{\partial k} dk + \frac{\partial F}{\partial \epsilon} \frac{\partial \epsilon}{\partial \tau} d\tau$$

Now finding the derivative of f with respect to z .

$$\frac{d\phi}{dz} = \frac{\partial F}{\partial \alpha} \frac{\partial \alpha}{\partial z} + \frac{\partial F}{\partial \alpha} \frac{\partial \alpha}{\partial u} \frac{du}{dz} + \frac{\partial F}{\partial \epsilon} \frac{\partial \epsilon}{\partial \theta} \frac{\partial \theta}{\partial z} + \frac{\partial F}{\partial \epsilon} \frac{\partial \epsilon}{\partial \theta} \frac{\partial \theta}{\partial k} \frac{dk}{dz} + \frac{\partial F}{\partial \epsilon} \frac{\partial \epsilon}{\partial \tau} \frac{d\tau}{dz}$$

And, since t, u and k are held constant,

$$\frac{d\phi}{dz} = \frac{\partial F}{\partial \alpha} \frac{\partial \alpha}{\partial z} + \frac{\partial F}{\partial \epsilon} \frac{\partial \epsilon}{\partial \theta} \frac{\partial \theta}{\partial z}$$

Remembering that the explicit function f was

$$\phi = \alpha - \epsilon = be^{-z} - e^{-\theta t} \beta$$

where

$$\theta = e^{-z} k$$

therefore

$$\frac{d\phi}{dz} = (1) (-be^{-z}) - (-1) (-te^{-\theta t} \beta) (-e^{-z} k) = -be^{-z} - tk\beta e^{-(z+tke^{-z})}$$

$$(-) = (-) - (+)$$

Notice the signs of the above derivatives. The slope of a is negative, and the slope of e is positive. It is interesting to note that the above computations reveal that in this model the change in f with respect to z is negative, or in other words— as the cumulative environmental damage increases, the perceived net benefit of environmentally damaging behavior declines. Since a and e in this model have been shown to have the slopes described earlier, then point z^* , as discussed earlier, must exist in this model.

If point z^* , an "optimal" level of environmental destruction is normatively unacceptable, however, the question of how to adjust the location of z^* arises. Theoretically, point z^* can be changed by adjusting the discount rate, (k) which is a society's basic opportunity cost rate. What, however, does this translate into in reality?

In reality, massive environmental destruction does occur in the name of short-run economic gain. Given the preceding theory, could or should a society's opportunity cost be manipulated or changed in order to lower the level of environmental destruction which occurs? Would such an attempt to change a society's k be merely normative egoistic tinkering on the part of the social scientist? Is the adoption of a normative equilibrium value superior to the realization of a positive equilibrium? These are very serious questions and ones which may not be answerable in the near future. Another possible way to change z^* , (should the normative decision be made to do so), would be to lower b , which is the short-term benefit of environmentally destructive acts. Perhaps this can be done with penalties by a government

agency on small individual units which benefit from environmental destruction. If, however, the government body either condones or refuses to act against such environmental destruction, how then could the b of an entire country be lowered? This can be accomplished only through international cooperation, which doesn't occur often.

What is most startling about this model is that it leads to the conclusion that the solution to the problem of excess environmental destruction may very well be an increase in economic development. This increase, if it lowers the opportunity cost of existence for individuals in small LDC's would then produce a lower equilibrium level of z^* . Extremely destructive environmental behaviour would go hand in hand with poverty in this model, and empirical evidence does exist to suggest that perhaps this is so. Recent empirical findings have shown poorer countries having less success in dealing with such problems as CO and nitrous oxide air pollution, and lead content in gasolines (Beckerman 1989,p.491). Such empirical evidence will be dealt with further in a forthcoming empirical test of this model.

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Dr. Glenna Sumner received her Ph.D. from the University of Oklahoma in 1993; she received her MBA from Southern Illinois University in 1987, and her BS in Business Administration from Southeast Missouri State University in 1984. Her main research interests include environmental economics, economic development, international trade, and energy economics.

Ms. Charlotte E. Ford
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